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THE PRODUCTION AND STORAGE OF DRIED FISH

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

THE PRODUCTION AND STORAGE OF DRIED FISH

Proceedings
of the
Workshop on the Production and Storage of Dried Fish

Universiti Pertanian Malaysia
Serdang (Malaysia), 2-5 November 1982

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PREPARATION OF THE REPORT

This supplement to the Report of the Fifth Meeting of the IPFC Working Party on Fish Technology and Marketing (FAO Fisheries Report No. 279) contains the twenty-six papers presented and discussed at the associated Workshop on the Production and Storage of Dried Fish. The Workshop was held at the Universiti Pertanian Malaysia, Serdang, Malaysia, from 2-5 November 1982. FAO wishes to thank the Government of Malaysia for hosting the Working Party Meeting and the Workshop and to acknowledge in particular the assistance received from the Organizing Committee of the Department of Food Science and Technology:

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ABSTRACT

The report contains the twenty-six papers of a Workshop on Dried Fish Production and Storage held at the Universiti Pertanian Malaysia, 2-5 November 1982. Papers are divided into the six following categories: Production of Dried Fish; Methods of Drying; Alternative Products; Storage Losses and Quality Standards; Physics of Drying, Water Activity and its Effect on Storage; Economics, Packaging and Marketing.

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SOME RECENT RESEARCH ON TRADITIONAL FISH PRODUCTS IN THE IPFC REGION

by

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ABSTRACT

An indication of some recent and current research topics in the field of traditional fish products in a number of countries of the IPFC region is given in this report. The report is based on visits to selected fish technology research institutions in Bangkok, Colombo, Dhaka, Jakarta, Manila, Serdang and Singapore during March-April 1982 and discussions with the scientists there. It is representative rather than comprehensive in coverage. The references given to literature are integral to the report as they pertain to the more recent research publications. The concluding part of the report discusses regional research requirements.

BANGLADESH

Fish production in Bangladesh during the year 1980-81 was 650 000 t (525 000 t inland fish and 125 000 t marine). Both inland and marine fish are preserved by sun drying; the smaller and even the longer sizes are sun dried without preliminary salting. It takes five-six days for complete drying of small fish and more than a week for large fish. *Hilsa ilisha* which constitutes about 40 percent of the total catch is the only fish preserved by dry and wet salting. Small shrimps are smoked and dried.

The Food Science and Technology Division of the Bangladesh Council of Scientific and Industrial Research is engaged in research programmes on solar drying of fish and production of FPC type B. The polyethylene tent dryer of Doe *et al.* (1977), has proved effective in controlling infestation by the larvae during fish drying and also in reducing drying time, especially toward the later phase. The tent has also been tested for drying pomfret and shrimp. Other types of tents, especially one with an arch type structure instead of the triangular one, are being tested and evaluated with Japanese collaboration.

The Fisheries Technological Research Station, Chandpur, has a programme to study various traditional methods of fish curing and preservation.

INDIA

Organized research in fish processing technology has been carried out in India for over two decades. Prior to this period, some work had already been initiated by the various State Department of Fisheries. At the national level, the Central Institute of Fisheries Technology, Cochin, with its sub-stations or units at Kozhikode, Bombay, Veraval and Kakinada, and the Central Food Technological Research Institute, Mysore, with its Fish Technology Experiment Station at Mangalore, have been the main contributors. The Bhabha Atomic Research Centre in Bombay has made contributions in the application of radiation to sterilization and pasteurization of seafoods. The College of Fisheries at Mangalore, under the University of Agricultural Sciences, Bangalore, has been active in recent years with its own research programmes in this field. Some of the State Departments of Fisheries, especially in the maritime States, have continued their efforts with small teams of workers.

Cured fish, i.e., sun dried or salted-sun dried fish is the only traditional fish product of overall commercial importance in India accounting for utilization of about 30 percent of marine fish landings. Curing is still the most effective and economic method of conserving seasonal and local surplus landings. For some fishes like Bombay duch, shark, silver bellies and a few others, the consumer preference is for the cured rather than for the fresh form.

Considerable research literature exists on all aspects of fish curing in India. The industry, however, remains traditional with full scope for improvement.

Picked fish meat and products based on it are seen as way of utilizing by catch fish. However, such products are novelties and not traditional to the Indian fish consumer. So also is smoked fish.

Some recent publications are mentioned under references.

INDONESIA

Out of the total marine fish landings of 1 227 386 t in Indonesia in 1978, 46.6 percent was utilized for all traditional products; as much as 35.5 percent for drying/salting, and 11.1 percent for other products. The actual quantities are given in Table 1.

Table 1

Production of traditional fish products in Indonesia in 1978

(in t)

Product	Quantity of marine fish used	Quantity of production
Dried/salted	435 738	248 052
Pindang (boiled fish)	65 985	48 558
Fermentation:		
- terasi	55 135	65 226
- peda	5 055	3 429
- sauce	262	237
Smoked	24 461	16 398
Others	5 895	3 979

The report of a survey of existing conditions of traditional fish procesing in Indonesia conducted from July 1976 to January 1979 by Toshizo Sawada, Fish Processing Expert under the Colombo Plan, is quite extensive. Besides describing the processing procedures, it offers guidelines for better fish handling and sanitation, stresses the need for the consumers to make complaints about the quality of the products, and delineates the improvements which are imperative in the processing procedures for preparation of the whole range of traditional products.

The Direktorat Bina Produksi under the Direktorat Jenderal Perikanan, has proposed bringing about the necessary changes by:

- conducting extension with literature leaflets and brochures, as well as by training and demonstration;

- opening a laboratory in every province to help improve the quality of traditional fish products, some of the laboratories having sheds with mechanical drying and smoking facilities;

- selecting a key processor in each area as the leader for introducing change by providing him with a package of facilities such as building, processing equipment and other infrastructure.

The Institute of Fishery Technology, in its programme under traditional fish processing, has been recently or is currently engaged in R. and D. programmes on some of the following aspects:

In Jakarta

(a) Effect of preliminary salting or delay in boiling on the quality of "pindang".

Study of boiling techniques in peparation of "pindang garam".

Heat-penetration in pindang processing with reference to microorganisms.

Use of spices like tamarine or turmeric root to improve the quality and shelf life of pindang.

Study of the microbiology of slime in pindang spoilage.

Improving shelf life of pindang by pretreatment with potassium sorbate and antioxidants and by packaging.

Study of techniques and facilities needed for manufacture of pindang and "dendang".

Examination of the concept of standards for processing and quality specification for pindang.

Socio-economic and techno-economic factors influencing the manufacture of pindang.

Influence of addition of starch during "trassi" processing - packaging of trassi.

(b) Development of prototype solar dryers for fish: direct absorption, indirect drying and combined direct and indirect dryers.

Study of the constraints in marketing and distribution of salted fish from outer Java to Java.

(c) Preparing an inventory of data on traditional processing in South Sumatra and introducing improvements in traditional processing in some villages there.

In Ambon

(a) Effect of handling cuttlefish on the quality of the dried product.

(b) Prototype kiln development for smoking of skipjack tuna, extension for improvement of traditional smoking technique.

(c) Processing of "katsuo bushi" and "arabushi".

(d) The influence on quality of salted fish stored at ambient temperature, amount of salt and packaging material.

(e) Introducing improvement in processing practices for production of salted fish in north Malaku and Sorong.

4. MALAYSIA

The total marine fish landings in peninsular Malaysia in 1980, was about 624 000 t. A little over 12 percent of this was conserved by drying/salting/smoking and about 3 percent by steaming/boiling, fermenting and other traditional methods. Some details are given in Table 2. The quantities of the different traditional products produced are given in Table 3 (source: Annual Fisheries Statistics 1980, Department of Fisheries, Ministry of Agriculture, Malaysia).

Table 2

Conservation of marine fish landings by traditional methods in Peninsular Malaysia in 1980

(in t)

Total marine fish landings	623 898
Quantity used for:	
drying/salting/smoking	77 240
steaming/boiling	7 993
fermented products	8 922
other products	1 029

Table 3

Production of traditional fish products in peninsular Malaysia in 1980

(in t)

Salted/dried fish	7 993	Boilded fish	6 394
Dried anchovies	9 436	Shrimp paste	2 699
Dried prawn	1 268	Prawn paste	32.7
Prawn dust	90.7	Pickled prawn	25
Dried cockles	1 297	Fermented anchovies	22.7
Dried cuttlefish	200	Fish cracker	637
Jelly fish	308	Shrimp cracker	32

It would suffice here to state that a fairly comprehensive description of the Malaysian traditional fish products industry and the state of art in it can be obtained from Reports Nos 31, 51, 147, 151 and 171 brought out by the Malaysian Agricultural Research and Development Institute (MARDI). Other relevant publications are also included under references. Some of the R. and D. problems currently being tackled at the Food Technology Research and Development Centre of MARDI at Serdang, its centre at Kuala Trengannu, and also at the Department of Food Science and Technology of the University of Agriculture, Malaysia, are mentioned here.

At FTRDC, Selangor

(a) Studies on anchovy sauce ("budu") and shrimp sauce ("cincalok"). While budu is produced only in Kelantan and Trengannu States, cincalok is produced only in the States of Johore and Malacca. The acceptability and market for these sauces are also localized in these regions. It is presumed that a less intense odour and colour may make these products acceptable in the markets of the west coast region as well. Besides, there is much variation in the degree of hydrolysis and sedimentation in the commercial products. This may need to be standardized.

(b) Studies on preparation of fish paste from non-traditional raw materials: "belacan", shrimp paste is traditionally made from *acetes* sp. and packed in kraft paper. Alternate packaging materials will be tried to improve the packing. An attempt will be made to produce similar products from non-traditional fish, especially freshwater species, and to study their acceptability profiles.

(c) Packaging of dried anchovies: equilibrium relative humidity characteristics of dried anchovies and studies on packing the product in polythene and polypropylene pouches are in progress. Studies had earlier been concluded on packaging and shelf life of fried anchovies.

(4) The use of a brabender extruder in producing fish crackers is being tried out.

At Fish Processing Centre, Trengannu

(a) Utilization for human consumption, of by-catches and underutilized species: fish balls, cakes, sausage and kroepuk are traditionally made from table fishes. It is intended to test and study the feasibility of low-cost species for making these products.

(b) Process for fermented fish ("pekasam"): study of the process, changes during processing, extension of shelf life and improvement of packaging in respect of the product made from freshwater fish.

At Department of Food Science and Technology, University of Agriculture

(a) "Satay ikan" - a spiced cook-dried fish product. Using low-price fishes, reducing sugar content in the sauce, i.e., wet ground spices, used in the preparation of the product.

(b) Preparation of fermented sauces from low cost marine fish and *Tilapia*.

(c) Problems of mold growth, rancidity and shelf life of fish crackers.

(d) Developing and testing hot air dryers for production of salted-dried fish to improve quality and storage life more specifically to:

(i) identify characteristics of the most popular dried fish products in urban and rural markets (chemical, microbiological and other);

(ii) identify site-specific constraints within which fish curers work in rural areas;

(iii) design, construct and evaluate drying technologies, utilizing solar and agricultural waste heat sources, to fit the process and product characteristics;

(iv) test the drying technology and other processing operations in rural areas.

THE PHILIPPINES

In the Philippines, the total fish production in 1980 was 1 672 254 t out of which the marine fish landed was 1 250 883 t and inland fish 285 420 t. About 30-33% of the annual catch is processed as salted, dried, smoked, fermented, frozen, canned and as fish meal. Although it is usual to think of the dry fish industry as a small-scale operation, it is interesting to note that in the Metro Manila area most of the dry fish processors operate on a medium scale with their average annual production in the range of 10-150 t and a few of more than 150 t.

Research in fish processing technology is being undertaken at:

The Fisheries Utilization Division
Bureau of Fisheries and Aquatic Resources;

The Department of Fisheries Technology, College of Fisheries,
University of the Philippines, Quezon City; and

The Department of Food Science and Technology,
University of the Philippines, Los Banos.

Some of the more recent and ongoing investigations on traditional fish products are mentioned here.

Fisheries Utilization Division, BFAR

The effect of freezing on pre-cooked Galonggong (big bodied round scad - *Decapterus macrosoma*) for smoking.

Drying of Galonggong using different techniques.

Study on dehydration procedures for mackerel (*Pneumatophorous japonicus*): pilot-scale production, chemical and microbial analysis, sensory evaluation.

Semi-pilot study of raduration of dried mackerel for extension of shelf life.

Preparation of smoked soft boned "Bangus", milkfish - "Chanos chanos".

Preparation of shrimp crackers based on shrimp and rice.

Department of Fisheries Technology, UP

Solar and artificial methods of drying round scad, frigate mackerel, mussels, oysters, squid and jelly fish; two solar dryers designated the boat-type and chair-type, another solar dryer with booster, a L-shaped smoke house (fed with coal instead of sawdust) used as an artificial dryer and an agrowaste dryer are all being evaluated for their performance. Dry fish samples from three major outlets in Metro Manila have been evaluated for their quality in terms of total plate count, yeast, mold, halophile counts, salt, moisture and sensory evaluation. Drying time requirements have been evaluated for round scad, frigate mackerel, mussels and squid.

Standardization of the smoking process for round scad, herring, faughns mackerel and mussels. Different smoking methods currently in vogue in the country have been considered for improvement. A torry kiln has been used to establish optimum conditions of smoking for each type of fish. Construction of smoke houses out of local material, but similar in principle to the torry kiln, is being taken up. The performance of such smoke houses will be evaluated.

Comparative analysis of round scad dried in a polyethylene tent dryer and under direct sunshine has shown that drying in the tents was faster and the dried products were of better quality. The two polyethylene dryers used were designated boat-type and chair-type.

The effect of sodium tripolyphosphate on the texture and on potassium sorbate on the shelf life of smoked *Sardinella fimbriata* has been studied.

Department of Food Science and Technology, UP

A three-year study on improving quality of smoked and dried fish has been completed. Several types of dryers have been evaluated.

A 1-t capacity forced convection dryer using rice hulls as a fuel source, which heats multi-tubed heat exchanger drums, a 5-hp diesel motor blower which blows heated ambient air through trays of fish has been designed and is being tested for fish drying. With inlet air temperature 54°C, air vel 30 m/sec, inlet air rh about 40% and rice hulls consumed at 10 kg per h, small herring and mackerel (*Sardinella fimbriata* and *Rastrelliger chrysozomus*) dried in 8-10 h to a 40% moisture level. The products were comparable to sundried ones. The BFAR is involved in the extension of the dryer to commercial interests.

SRI LANKA

Dry Fish

Of the total marine fish landings in Sri Lanka of 164 775 t in 1980, about 10% is used for production of dried fish. This domestic production provides only a fourth of the dry fish consumed, three fourths being met by imports. The inland fishery catch of about 20 000 t, on account of its lower consumer preference to marine fish in the fresh form, is also partly converted into dry fish. The Ministry of Fisheries has a programme

to upgrade the production of dry fish by provision of adequate facilities for drying and by improving techniques of sun drying to prevent waste and spoilage. Polyethylene tent dryers of Dr Doe's design have been demonstrated to the inland fishermen at Polonnaruwa, who seem to have appreciated the advantages gained by way of quicker drying and improved sanitation. The problems in regard to quality of dry fish are more in respect of imported products (traditionally procured from India, Pakistan, Maldives and occasionally from the Eastern neighbouring countries) than with local products. The detrimental effects of high moisture content, high ambient humidity, consequent mold growth or "pink", and insect infestation need to be overcome. This has been the object of some recent research investigations.

In analysis of 39 samples of dried/salted fish from the Cooperative Whole-sale Establishment, Welisara, which provided only imported products and from retail stores in Colombo which had both imported and local dry fish, Goonawardene *et al.* (1978), found the analytical parameters of quality to be in the following ranges:

> moisture content 35-50%; salt content 10-25%; salt content, dry basis, 25-35%; total count (marine agar), 10^4-10^6/g; potato dextrose agar 10^2-10^3/g and halophilic agar 10^1-10^2/g. *Coagulase* + ve *Staphylococci* were not detected.

The authors have compared the above data with the proposed standards of Sri Lnaka and existing India and Pakistan standards. They found that the majority of samples did not conform to any of the specifications.

Goonewardene and Etoh (1980) studied the keeping quality of two samples each of locally produced freshwater and marine, salted and dried fish which were 7 and 4 days old when procured. The samples were held uncovered in plastic boxes at the room temperature of 24°-36°C and rh 65%-86%. The dry marine fish kept for 51 days and the dry freshwater samples had much longer shelf life. Pink bacterial growth and white fungal attack were observed only in the marine and not in dry freshwater fish. The dry marine fish samples absorbed more atmospheric moisture. The authors suggest it would be more economical to reduce the moisture content of dry marine fish rather than salt them more. Following up this cue, Etoh and Goonewardene (1980) redried locally-produced salted-dried marine fish. This increased the shelf life from 51 days by an additional margin of seven days when stored unpackaged. Packaging in composite kraft paper/ polyethylene sacks following the redrying, however, increased the shelf life appreciably to over 87 days. Extending these studies to imported dry fish as well, Goonewardene and Etoh (1980b) studied the keeping quality of the product procured from India and Pakistan. They could prolong the shelf life by about 12 days by redrying without follow up packing. In the imported product, high moisture content is the main drawback. This could be due to inadequate drying in the exporting country or re-absorption of moisture before export, during transport by sea or during storage at the wharf in Colombo port. The solution is, therefore, clear-redrying and packaging. The subjective assessment system of inspection for acceptance of imported dry fish, which is dependent on visual inspection for moisture, absence of bacterial pinking, mold growth, etc., has been found to be reasonably accurate.

Other Products

"Maldive" fish: smoked, dried strips of tuna, a product of Maldive Islands, is a popular and expensive commodity in Sri Lanka, known as "Umbalakada" or "Maldive" fish. At the Institute of Fish Technology an attempt is being made to prepare a standard product for demonstration of the procedure to Sri Lanka fishermen to help supplement their income.

Colombo curing: research work on Colombo cured fish, a wet salted product called "Jadi" in which a dry sour fruit "Goraka" is included during curing, is contemplated at the Institute of Fish Technology. The traditional preparation of this product on the southwestern coast of Sri Lanka seems to be a disappearing art. The liquor generated during Colombo curing is called "Lunijje" and is used in a variety of dishes for flavouring.

Dried products: cooked, deboned, dried silver belly meat blended with onions, spices and salt is a product developed at the Institute of Fish Technology and being produced by the Ceylon Fisheries Corporation. Another product named "Marine Chicken"

is alcohol extracted silver belly meat in granular form for use as a meat replacer in meat balls, meat leaf, cutlets, Chinese rolls, etc. Fish sausage, traditional in some other countries but a new product for Sri Lanka, has been packed in Ryphan casings and processed at 121°C for 45 min.

SINGAPORE

Fish Balls and Fish Cakes

Dry fish and a number of other processed fish products are of relevance to Singapore, only insofar as this place is an important transshipment point for such commodities. The most important traditional product is the Chinese type of fish ball. There are reported to be about 350 licensed processors of fish ball and fish cake ranging from stall holders in the markets to small factories, and one factory specializing in these comminuted fish products, utilizing about 2 to 3 t fresh and frozen fish every day.

The species which are preferred for high quality fish ball and cake are expensive and marketable as table fish without processing. There will thus be considerable economic advantage gained if low-value, abundant and underutilized fish can be used for making traditional comminuted products. Leaching the minced meat and modification in the procedure for making fish balls have helped to obtain products with satisfactory resilience and springiness from low value fish like catfish, threadfin bream, lizard fish and *Tilapia* spp. The production of frozen *surimi* of satisfactory quality and its utilization for producing fish balls and fish cakes would help to stabilize the availability and supply of raw materials, besides centralization of their treatment for manufacture of comminuted products. Study of the gel forming ability of *Tilapia* and low market value fish is integral to such an effort. The Marine Fisheries Research Department of the Southeast Asian Fisheries Department Centre at Singapore, with its well laid out pilot production facilities, laboratories and programmes to transfer the know-how to fish technologies and processors in Singapore and the Southeast Asian region, is an example worth emulation by any fish processing technology laboratory, in terms of the relevance of its R. and D. programme and bridging the gap between research and its application.

THAILAND

Of nearly two million tons of fish landed in Thailand during 1979, about 9% was subsequently dried and salted, 5% converted into sauce and nearly 2% steamed or smoked; fermented freshwater fish and marine shrimp paste accounted for about 0.7% each. Some relevant figures in this regard are given in Table 4.

Table 4

Utilization of fish landings for production of traditional fish products in Thailand during 1979

(in t)

Landings	Marine 1 813 158	Freshwater 133 176
Dried and salted	148 117	24 190
Dried shrimp	18 306	94
Fish sauce	79 591	2 808
Steamed or smoked	30 830	4 960
Fermented	-	13 662
Shrimp paste	14 207	109
Fish used for traditional products Quantity	291 051	45 903
%	16.05	34.47

From Fisheries Record of Thailand 1979, Department of Fisheries, Ministry of Agriculture and Cooperation

Recent and Current Research Activities

At the Fishery Technological Development Division, Department of Fisheries, Bangkok:

(a) About 0.8 million ton of trash and other food fish are converted into fish meal in industrial units. A project on preparation of fish balls aims at diverting at least a part of this fish for preparation of fish balls.

(b) Ten of the top species landed are being studied for the quality attributes of their meat in such terms as whiteness of colour, good gel strength, possibility of obtaining good round shaping, but not too hard texture.

(c) The relationship of the gel forming ability of minced flesh (picked meat) derived from low-cost fish including some freshwater fish to their content of myosin, salt and water soluble proteins and ph, has been examined. Myosin content correlated well with the gel forming ability of the minces.

(d) In experiments conducted to study optimum processing techniques for fish ball making, it was found that the most acceptable fish ball was prepared by grinding minced fish for 10-15 min with 10% by weight crushed ice, 3% common salt and 0.3% potassium pyrophosphate.

(e) Fish balls, so prepared from threadfin bream, do not keep well for a full day at room temperature, keep for less than seven days at 3°-4°C in a refrigerator and for seven days at 0°C with ice. Freezing is not suitable as it causes breakdown of structure.

(f) The suitability of freshwater fish such as carp, catfish, *Tilapia* and milkfish for salting, drying and smoking has been tested with a view to improve their utilization. Each fish was more suited to a particular process.

(g) A mechanical fish dryer, suitable for pilot plant use, to study drying conditions, has been designed and fabricated. The heaters are thermostatically controlled and the air blower (centrifugal fan) by a variable speed pulley on its motor.

(h) A fish smoking kiln, suitable for small-scale production and pilot plant use, has been fabricated out of galvanized iron sheets fixed on a wooden framework.

(i) Production of "Pla-rah" from trash fish is being investigated. This fermented fish product is produced traditionally from gutted fish, mainly freshwater species.

(j) Studies on chemical changes during fermentation of "Kapi" and the microflora involved are in progress. *Coryneformes* and *Streptococci* seem to be the predominant flora. (Kapi is fermented fish paste made from small shrimp and small fish.)

(k) Procedures have been worked out for making a number of products from freshwater catfish: semi-cooked smoked products, salted products, roller dried sheets of minced meat, sweetened sliced meat, fish biscuit, seasoned dried sliced meat and ground fish, fish cracker, fermentation with pineapple, and fish ball.

(l) Minced fish, well mixed with soy sauce, spices, sugar and salt and rolled into flat sheets yields a product which can be fried for serving.

(m) Threadfin bream, converted into dried smoked fish, then ground with ingredients like salt, dry chillies, MSG is a new low-cost product.

(n) Fish crackers have been made using tapioca flour as the substituted starch component.

(o) FPC Type B has been prepared from trash fish in three forms, viz., from whole fish, and ground smoke-dried whole fish and ground smoke-dried dressed fish.

At the Institute of Food Research and Product Development, Kasetsart University, Bangkok

(a) As part of an overall programme of the National Research Council, Ministry of Science and Technology, on "Traditional Fermented Products Based on Fruits, Vegetable, Meat and Fish":

(i) collecting data on packaging materials and packaging suitable for fishery products, study packaging such as plastics, paper, tinplate currently in use by the industry;

(ii) study of the chemical composition of the commercial products drawn from the market and obtaining their preparation history.

(b) Testing the acceptability of Fish Protein Concentrate Type B and a roller dried fish product in Thai food preparations among low-income groups.

SOME REFLECTIONS

Fish preservation by salting and/or sun drying in the least expensive processing method and perhaps the only one that keeps the costs sufficently low for the end product to be within the reach of people of low-income groups. Research has endeavoured to study the quality of the cured product and the salt used, the salt-curing and drying processes, and the packaging aspects. It has been repeatedly pointed out that it is possible and necessary that cured products of much better quality than at present available in the markets should reach the consumer.

High moisture content, on account of incomplete drying and/or atmospheric moisture absorption due to inadequate conditions of storage, makes the product susceptible to growth of mould, halophilic pink or red bacteria and consequent deterioration of quality. Development of yellow, brown or other discoloration, rancid and other off-odours, hard or soft texture, contamination with sand are well-known defects. Problems of insect or larval infestation during drying and storage have to be overcome. Lack of sanitation and hygine in fish handling during dressing, salting and drying oprations is also recognized.

Use of purer common salt, low in calcium, magnesium, water-insoluble matter and free of halophilic bacteria, use of bacteriostatic and fungistatic food preservatives like sodium benzoate, sodium benzoate, sodium propionate and potassium sorbate, and of antioxidants like BHA besides adoption of improved process procedures especially with respect to final moisture content and proper retail or bulk packaging, are all suggested remedial measures. Streamlined production to permit hygienic handling, improved sanitation and quality control is also needed.

Improvements along these lines have for long been recognized as necessary, but the desired transformation of the industry is not perceptible anywhere. The mechanisms by which the findings of the research laboratories can be brought into actual application have not received adequate attention. It is immaterial whether such studies are conducted by the research scientists themselves or by their counterpart extension workers, but such studies are crucial to transfer of know-how.

It is possible that the very structure of the cured fish industry and trade in the product have inhibited improvements. To cite from an experience from India where attempts were made to demonstrate an improved curing procedure for salted, sun-dried mackerel involving the use of salt to which sodium benzoate, sodium acid phosphate and BHA were added, with obvious and well tested advantages. The curers were indeed impressed by the obvious beneficial effect on product quality. However, their main point was that their product does not stay with them long enough for them to bother about storage deterioration. They depend on low profits of quick returns, speculate and sell their product at the first opportunity. The traders and merchants can only deal with the products they buy; they too speculate and depend upon quick returns. The cost of loss of product or product quality in the trading chain is passed on to the final link with the consumer paying for everything. Perhaps this situation is typical of all regions with local variations. Thus there is no incentive for the primary producer, i.e., the

curer to produce better products, nor for anybody in the trade chain to care. The consumer must be satisfied with the product he gets. This reveals the need for two types of study, first, evaluation of quantity and value of cured fish products lost between production and the consumer, and secondly, an appraisal of the trade chain with a view to improving it. It is here that the Sri Lankan finding on the benefit of redrying and packing of dry fish within a few days of its production finds its relevance.

How about the consumer? He is perhaps conditioned to the product he has been buying. Not that he cannot eventually be reconditioned to a better product. He makes his choice even now based on <u>his</u> perception of quality and price. There have been occasions when a normal consumer of dry fish has been offered an ideally produced laboratory product and he complains of bland taste and flavour. What is off flavour to the research scientist could be development of flavour to the consumer. It seems therefore that there is need to study and codify perception of quality of dry fish by different cross sections of consumers.

What has been stated in the preceding paragraphs about dry fish also holds for other traditional fish products with due modifications.

The question of sanitation and hygiene also comes into the picture. It must indeed appear a paradox to consider that most of the traditional methods of preservation have perhaps originated under conditions where sanitation and hygiene were lacking. How does such lack show itself up in the end-products? It is necessary to investigate and distinguish those measurable quality defects of public health significance which are carried over from the processing stage and those from subsequent storage. Studies on microorganisms or their metabolites in the traditional fish products are not adequate.

A related point is whether sanitation and hygiene are only possible under affluent conditions. Surely, a treated water supply is needed and is not easily obtained at the sites of traditional fish processing. The export-oriented fish processing industry, notably prawn freezing, has taken all measures needed to meet stringent quality requirements. If we consider the economic status of the traditional fish processing industry as a whole, not only the few exceptions, then there is need to leap frog into adoption of sanitary and hygienic practices in processing without awaiting slow-to-come affluence. It is comforting to think that sanitation and hygiene are more matters of training and outlook rather than concomitant with affluence.

This leads us on to the inspection and quality certification systems that have been brought into practice for exported fish products. The foreign buyer demands quality, and is catered for. The internal consumer does not demand quality, does not bring in foreign exchange and so is not catered for. It seems necessary to impress upon governments, with supporting data and information, that instituting quality inspection and certification systems for traditional fish products without necessarily passing on its costs to the producer or the consumer is important. They do not appear to be convinced at present. It is therefore heartening to note that in Indonesia plans are afoot to open laboratories in each province to help improve the quality of traditional fish products, and a key processor is to be selected in each area as a leader for introducing change by providing him with a package of facilities.

Different types of solar and other fish dryers are being experimented upon in the countries of the IPFC region as elsewhere. Each type may find application and acceptance under a specific set of conditions. This should not however make us lose sight of the obvious advantages of direct sun drying of fish and the need to improve sanitary conditions in direct sun-drying practices. Where inclement weather is not a problem, direct sun drying can be depended upon to yield good products. Drying space, however, should be adequately available. Change over to off-the-floor drying, i.e., sun drying on raised platforms has not been yet made in India whereas it is traditionally practised elsewhere, for instance, in Thailand. When sun drying is spread over a number of days, as for larger fish, the intermittent drying turns out to be advantageous. Overnight diffusion of moisture to the surface of the drying fish, aids drying the next day. Even when dryers are used, it may be desirable to take recourse to much intermittent drying.

Direct or indirect insolation dryers with no augmented air circulation to force out the humid air leave much to be desired. They have little merit in the initial phase of drying when exposure to wind assists in the drying process which is governed by convection from the surface. This holds even when agricultural wastes are used as heat source without forced air circulation. The fish cannot be easily turned out over in the dryers and higher temperatures may tend to cook the fish rendering the dried fish brittle. Thus dependence on air blowers seems essential. However, it would be worth experimenting whether by a proper design of the drying chamber and chimney (air outlet), humid air can be removed by the force of natural air circulation.

Dry powdered fish products, plain or spiced or as FPC type B, are being developed in many laboratories. Such products are being derived from whole, eviscerated fish or picked fish meat. These are necessarily new products needing considerable effort to create a sizeable voluntary consumer market. It is, however, different if these find place in subsidized nutritional programmes.

Picked fish meat from comparatively low-cost fish has a greater chance of success in regions where fish ball and other fish paste products are traditional. In countries like India, it needs a market development effort. Fish sausage has been thought of as a possibility for 20 years now in India, but has not yet gone commercial.

The Mexican process for making salted-dried fish cakes out of picked fish meat does not appear to have stimulated much interest in the IPFC region. The potential market for such a product in areas where dry fish is an accepted consumer item cannot be underestimated.

Exchange of research results, reports and publications among the different laboratories of the IPFC region will be of considerable value, especially when there are so many common problems - fish dryers, utilization of low-cost marine and freshwater fish, picked fish meat, to mention the few obvious ones. Exchange of research personnel would be even more beneficial. FAO and other agencies can be of help in this regard.

An apsect that has necessarily remained outside the scope of this report is inter-country trade in traditional fish products. There may be problems to be solved or untapped market potential. For instance, there could be a market for dried anchovies or anchovy sauce if these products can be properly produced in India. Institutions like INFOFISH could perhaps study this inter-country trade aspect.

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DRIED FISH: AN ASIAN STAPLE FOOD
(A preliminary report on a joint study by the Asian Development Bank and FAO)

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ABSTRACT

Asia has long been one of the world's leading production and consumption areas for dried fish products. This article is based on a study of eight countries: the Philippines, Hong Kong, Singapore, Indonesia, Malaysia, Thailand, Sri Lanka and Pakistan.

PRODUCTION AND CONSUMPTION

Total production of dried fish products (dried weight) in the countries covered was about 774 000 t in 1980, about 20 percent of total world production. Indonesia accounted for more than half, followed by the Philippines. In both countries a significant proportion of total fish landings is dried (58 and 46 percent respectively).

Consumption varied widely within the region. Not surprisingly the two most densely populated countries, Indonesia and the Philippines, consume the greatest total volume and also show the highest *per caput* usage. Total consumption exceeds production because Hong Kong and Sri Lanka are both net importers.

The low figure for Singapore may not be realistic since information on local production is not available and because some product may reach the market, unrecorded, from nearby Sumatra and Malaysia. Our guess is however, that additional inputs from these sources are not large.

Production and consumption trends differ in interesting ways within the region. Sri Lanka now shows a definite preference for fresh fish and between 1970 and 1980 imports of dried fish products fell from 37 000 to 4 000 t. Meanwhile, domestic production has increased very little. On the other hand, Indonesia and the Philippines have both increased dried fish production and *per caput* consumption.

Production methods and quality standards vary slightly from country to country. In most cases, processing is done in a traditional manner with little regard for hygiene. The fish are often butchered, salted and dried on sand beaches which sometimes are heavily polluted. As much as ten percent discount at wholesale level is allowed for sand and dirt adhering to the dried product.

Quality is more important in South East Asia. Usually fish are dried on elevated split bamboo trays so that the final product is clean and free from foreign matter. The main problem in that area is spoilage due to weather changes during the drying process, causing unevenly dried fish with tough meat, bruised skin, and other damage. High quality dry fish products cannot be produced if there are fluctuations in the drying conditions. The University of the Philippines at Los Baños has developed a simple and inexpensive food drier which can use, either solar power or simple non fossil fuels such as wood or biogas. Use of such equipment should improve quality as it protects the product from insects during processing. Development programmes on mechanical dryers are conducted in almost every country in Asia.

Processing methods are simple. Most smaller species such as anchovy (*Stolephorus* spp.), small sardines (*Clupea* spp.), small shrimp, cuttlefish and squid are sun dried without salting. Medium size finfishes such as Indian mackerel (*Rastrelliger* spp.), round scad (*Caranx* spp.), small grouper (*Epinephelus* spp.), rabbit fish (Siginidae) and smaller breams (Nemipteridae) are split, gutted and brined in saturated brine before being laid out to sun dry. The brining time varied from country to country. In the Philippines where inventories are kept in cold storage it is only 20-30 minutes. In Indonesia, brining may take several hours.

Larger fish such as snapper (*Luthianus* spp.), Spanish mackerel (*Scomberomorus* spp.), threadfin (*Polynemus* spp.), leatherjacket (*Chorenemus* spp.), and rays (*Dasyatis* spp.) are most often split, gutted and dry salted and stacked, then re-salted and sun dried. Alternatively, these species may be filleted and dry salted and sun dried. Threadfin is cured that way and the resulting product commands high prices and market acceptance in Malaysia, Thailand and Singapore.

One product which is almost exclusive to Java (Indonesia) is locally known as "pindang". A total of 55 000 t of this product is prepared and consumed annually on Java. The process consists of boiling almost any species of finfish in a saturated salt solution. The brine is poured off and the fish is tightly packed in wooden tubs, tautly-woven and lined baskets or clay pots. Shelf-life is about six days at ambient temperatures.

Another regionally popular product is a freshwater species called guarami (*Trighogaster* spp.). The small fish (average 15-20 cm) is simply headed, gutted, brine soaked and sun dried but retains a relatively high moisture content estimated to be about 40-50 percent.

PRODUCT HANDLING AND TRANSPORT

The entire region uses similar packaging materials and packing methods. Shippers use large woven palm leaf containers (often containing up to 300 kg) to transport the dried product to urban or intraregional markets. India uses the same type of container but wraps it in burlap. Cane baskets containing 25-30 kg are also used often throughout the region. Wooden boxes are employed for inter-island shipments as well as export shipments in the Philippines. These are standard-sized units, containing about 25 kg of products. In Malaysia plastic and cardboard containers are being used.

Transport for local distribution is always by motor truck. Dried fish brought into Malaysia and Singapore from Thailand or Burma comes in by motor carrier. In Indonesia, dried fish is often transported between islands by small motor vessels of 200-300 t cargo capacity. In the Philippines, inter-island shipments travel by commercial cargo vessels and containerized cargo is coming into use from major out-ports such as Cebu, Iloilo, Zamboanga City, Davao and Cagayan de Oro. Intraregional and foreign shipments move by commercial shipping lines.

MARKETING PRACTICES AND CHANNELS

Dried fish product sources are always at or near important fish landing areas or fishing villages. Here either fishermen and their families or people in the fish processing business produce the dried/salted/smoked fish product and added value invariably results. In remote areas and in glut seasons, drying or other processing methods (such as fish sauce manufacturing) is the only way to ensure that the fish catch gets to the market.

In Asia, the market is no constraint to production; all dried fish products find their buyers. More exotic products such as dried squid, cuttlefish, bêche-de-mer, scallops, oysters and abalone are always in short supply. Products that are sour or otherwise spoiled for human consumption are taken care of and are utilized for animal feed. Spoiled salted fish for instance, makes good pig feed while the unsalted product is often used as poultry feed.

Dried fish is purchased by a fish dealer or middleman living near to the processor; sometimes by an individual or company also engaged in fish processing, and having direct contact with the dried fish wholesaler, usually in an urban centre or other distribution point. Often the middleman receives cash advances from the wholesaler and he may, in turn, finance processors who supply him regularly. He keeps the wholesaler well informed and arranges shipments ordered by the wholesaler. He is usually paid by the wholesaler on a commission basis although some independants finance their own operations and work on a margin.

The next link in the chain and the pivot of the trade is the wholesaler. His expertise in the dried fish trade consists in knowing when to buy and when to sell. In the Philippines, Malaysia and Hong Kong where inventories are kept in cold storage,

wholesalers make a very good margin by holding large quantities of the higher priced products purchased at low prices during glut seasons and selling when higher prices can be fetched.

In Jakarta and Manila, wholesalers handle very large quantities of dried fish and dispose of their inventories by auction. Almost daily they are visited by distributors coming to see lots of dried fish on display. When the wholesalers feel enough buyers have gathered they start the auction. Lots are generally quite large, 300-500 kg, and often several hundred tons of product is sold at each auction.

The wholesaler gets his inventories either from the middlemen or directly from the processors. In addition to advancing money to middlemen and other product sources they also extend credit to the buyers. In Manila, they accept post-dated cheques from buyers before removing purchases from the auction floor.

The distributors sell to retailers and often operate one or more retail shops of their own. Distributors commonly extend credit to retail shop owners on a short term basis.

Most retailers are in public markets. In Jakarta, many operate as bicycle vendors. In high-consumption areas such as the Philippines, Indonesia and Hong Kong retailers sell dried fish exclusively. In other countries (e.g., Malaysia, Thailand, Singapore and Sri Lanka), they handle dried fish products along with fresh fish and/or other food items.

Fish exporters often work outside the marketing chain. Generally they are traders who have direct connections with processors/producers of certain products such as dried squid, bêche-de-mer, sharkfin, etc., and usually deal in only one or two commodities. In some cases, however, the wholesaler also exports directly.

The foregoing description applies to the typical high volume marketing chain, but there are many variations to this system, especially in provincial areas where a retailer may buy direct from the processor. In Sri Lanka where a large part of dried fish is imported, nearly all products are distributed by a Government agency at controlled prices. In Hong Kong, the Government's Fish Marketing Organization (FMO) acts as auction agent for nearly all of the locally processed products. The majority of the Hong Kong dried/salted/smoked fish supply is however imported and distributed by private traders.

The profit margins retained by each entity in the marketing chain varies from country to country. In Hong Kong, a 300 percent spread between processor and retailer is common. In the Philippines, the spread is slightly smaller; Sri Lanka has the lowest margins with an estimated average of less than 50 percent between import and consumer prices.

CONSUMER REFERENCES AND BUYING HABITS

The countries surveyed show some common product preferences, namely, dried anchovy, dried small shrimp and dried squid and they can all be found in markets from Colombo to Hong Kong. In the more quality-discriminating countries such as Thailand, Singapore and Hong Kong, these varieties can be separated into as many as eight categories according to quality, grade and size. In Hong Kong, the top price market in Asia, premium quality fetches US$ 6.50 for dried anchovy, US$ 12.50 for dried squid and up to US$ 17.00 for dried shrimp per kilo.

Other species are common to all countries in the area but different consumer preferences can be noted. Sri Lankans as noted are showing a preference for fresh fish. The Philippines are going the opposite way; each year a greater percentage of the national catch is processed into dried fish.

Pakistan is not a dried fish consumer but has, in the past, been a major producer of dried fish products mainly to Sri Lanka. Although this trade has greatly diminished, Sri Lankans still favour the large finfishes such as Spanish mackerel, jewfish and threadfin, produced by Pakistan, over smaller varieties locally processed. These large species are not processed in Sri Lanka because their value is much greater on the fresh fish market. The Pakistan product is low priced because of the lack of domestic market.

In Thailand, the most favoured species is the freshwater "guarami". Oddly, this fish has no appeal on the fresh market, but brined and dried, the first quality retails for as much as US$ 5.00 per kg. It is also popular, though to a lesser extent, in Singapore and Jakarta. Dealers there told us this species is always in short supply.

Although quite expensive, salted-dried threadfin fillets are a favourite in Malaysia and Singapore. This thick, meaty product is prepared in large quantities in Burma and reaches neighbouring markets via informal trade routes. It is also popular in Thailand.

Java's favourite is pindang which can be made from any kind of finfish with medium-large species preferred. In Java, it is more popular than either dried or fresh fish. Apart from pindang, Indonesians seem to prefer dried and salted-dried small and medium sized pelagic species. In the Sulawesi area of North Central Indonesia, smoked fish is preferred.

Hong Kong is the most selective market in terms of product type and quality. Over US$ 98 million worth of dried/salted/smoked fish products are imported annually and 70 percent of these are made up of "gourmet" products such as dried abalone, dried scallops, dried beche-de-mer, dried shrimp, dried sharkfin and dried squid. Only the very best quality of any product is sold in the markets. Neighbouring mainland China absorbs any surplus or grades sub-standard to Hong Kong's demands.

Most areas are affected by seasonal production peaks as well as by periods of short supply. This is particularly true in the Philippines which experiences two annual monsoons, the Southwest from June to September and the Northeast through February. Dried fish market prices fluctuate to extremes between the lean and the glut seasons.

Hong Kong, Singapore and Malaysia have peak demand seasons for the "gourmet" dried fish products, during Chinese holidays (especially Chinese New Year) and in the popular Chinese wedding season, July to September.

EXTERNAL TRADE

Except for Hong Kong, very little dried fish product is imported into the area. Interregional trade is modest except for Thailand where over US$ 30 million in foreign exchange is earned annually, mainly by the export of high quality dried squid and cuttlefish.

Most of the trade, both interregional and foreign, is in the more exotic and high priced products such as beche-de-mer, squid, cuttlefish, abalone, sharkfin, shrimp and top grades of anchovy. Imports noted for the Philippines and Thailand are mainly gourmet products such as smoked Atlantic salmon or smoked oysters for the international hotels and airline kitchens. Thailand imports some high quality salted-dried threadfin fillets from Burma.

The Philippines and Indonesia do not import any dried fish products for their regular domestic markets. Malaysia imports sharkfin, threadfin fillets and other dried fish products mainly from Thailand and Burma. Singapore imports consists mainly of dried squid and guarami from Thailand, fish maw and sharkfin from India, finfish from Malaysia and Indonesia and dried oysters from Korea. Much of this product is re-exported.

Hong Kong imports about 16 000 t with an average value of US$ 6.15 per kg. These imports account for a large share of the interregional trade and also involve dried fish exporters world wide. It can be said that the Hong Kong market receives the very best of high quality dried marine products available on world markets.

Exports throughout the region are mainly to other countries in the general area. Nearly all of Pakistan's dried fish production goes to Sri Lanka. Indonesia's exports consist mainly of dried fish roe which goes to Japan and an emerging dried anchovy export trade destined for Sri Lanka. Sharkfin from all countries in the region goes to Singapore and Hong Kong. Thailand's dried squid production is absorbed by Japan, Hong Kong and Singapore. The Philippines ship large quantities of beche-de-mer to Hong Kong, as well as some dried abalone.

With the exception of Pakistan and Singapore, none of the regional countries surveyed are very export-oriented. The larger producers, Indonesia and the Philippines, cater to

an insatiable local demand and dealers do not seem interested in other markets. The large export volume of squid in Thailand is handled and controlled by traders who have little to do with domestic marketing activities.

Pakistan could greatly expand the dried fish trade, expecially from the remote Baluchistan areas where disposal of the catch to fresh markets is virtually impossible because of lack of communications infrastructure.

Pakistan has the ideal climate for sun drying. To make such a project viable, the processors would need to be trained in quality control techniques of processing and handling. Pakistan could then be expected to improve the dried fish trade for export earnings. Their prices are competitive and the fish species available are the ones preferred on the market.

Table 1

Dried fish production 1980

Country	Share of each country's total landings (%)	Total dried fish products (dry weight) M/tons	Market share of total dried fish products (%)
Philippines	46.0	216 000	28.0
Hong Kong	10.0	6 200	8.0
Indonesia	58.0	438 300	57.0
Singapore	na	na	na
Malaysia	12.0	21 300	3.0
Thailand	11.6	80 000	10.0
Sri Lanka	4.6	9 000	1.1
Pakistan	3.5	2 800	0.3
		773 600	100.0

Total local consumption of the above countries in 1980 was 779 700, slightly more than production. This is because Hong Kong and Sri Lanka import fish to make up for a market deficit.

Dried fish products extracted from the INFOFISH database

Hilsa
Giant sea perch
Pollack
Congereel
Bombay duck
Catfish
Jewfish
Rock cod
Yellow croaker
Conger eel
Red snapper
Leatherjacket
Mullet
Pomfret
Black pomfret
White pomfret
Indian salmon fishmaw
Horse mackerel
Herring roe
Sardines
Golden anchovy

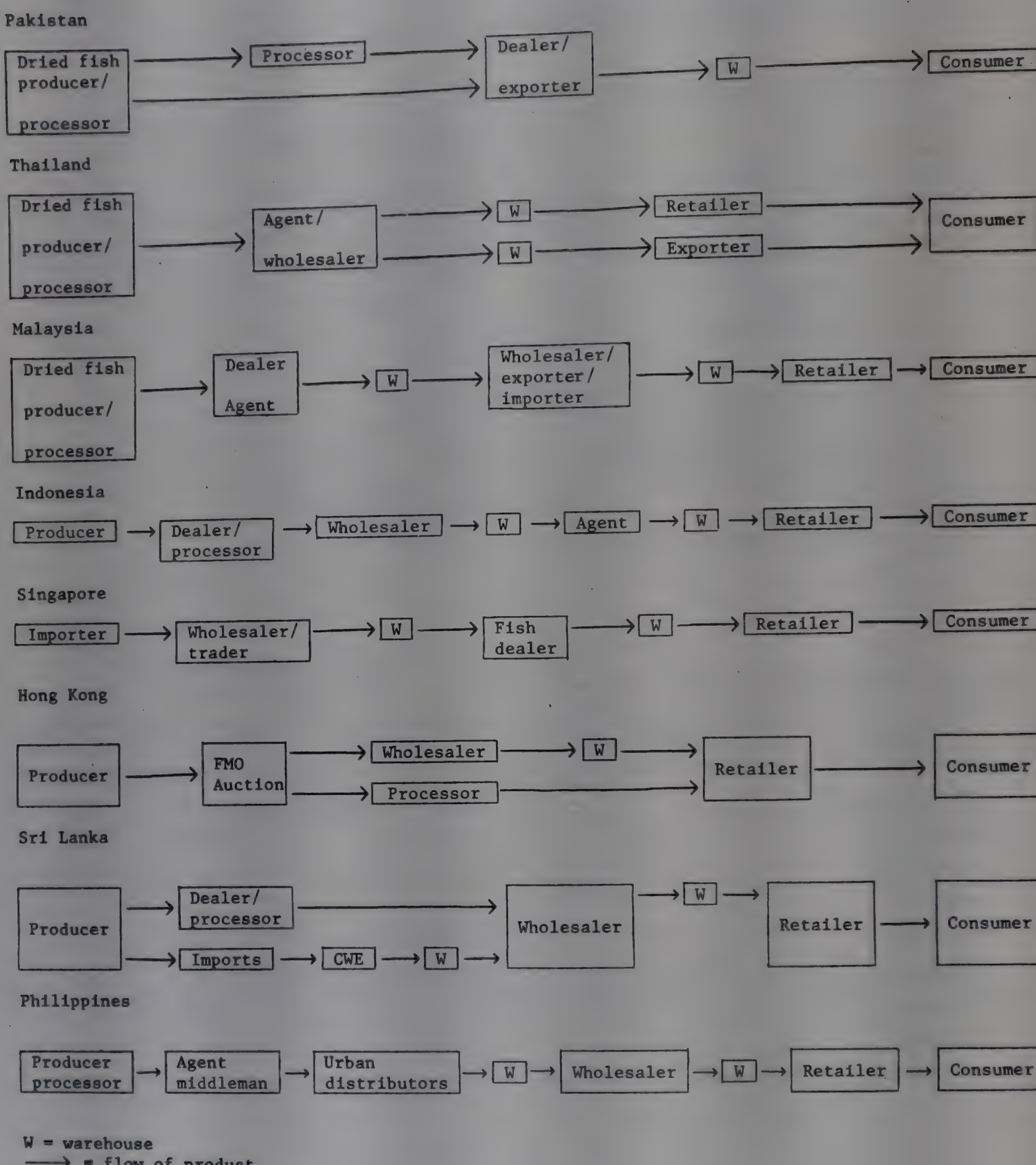
Anchovy
Frigate
Kawakawa
Seer fish
Skipjack
King mackerel
Mackerel
Dog fish
Sharks fin
Skates/rays
Sea horse
Shrimp
Abalone
Oyster
Scallops
Cuttlefish
Squid
Turtle shell
Beche-de-mer
Jelly fish

Per caput consumption of dried fish 1980

Country	kg/*per caput*
The Philippines	4.4
Hong Kong	3.8
Indonesia	2.9
Malaysia	1.5
Thailand	1.4
Sri Lanka	0.9
Singapore	0.8
Pakistan	0.1

External trade of dried fish
(million US$)

Country	Imports	Exports
The Philippines	0.7	2.1
Hong Kong	98.9	1.2
Indonesia	-	7.8
Malaysia	9.5	9.2
Thailand	1.8	32.1
Sri Lanka	18	16.7
Singapore	4.0	-
Pakistan	-	2.2



Marketing channels for dried fish vary widely from country to country

APPENDIX

The following list is a print-out of product descriptions which were sent to INFOFISH by exporters/producers in the Asian/Pacific region.

These descriptions are partly incomplete and are still in the process of being amended according to new information received.

The first digit (4) stands for dried products; the order is the result of the ISCAAP group number and the alfa identifier. The last 6 digits are internal codes used by INFOFISH, representing product form and processing details.

D R I E D

4HIL24000000 - HILSA
4GIP25379100 - GIANT SEA PERCH
4ALK32000910 - POLLACK
4ALK32001000
4ALU32230000
4DPC33000000 - CONGEREEL
4BUC33000100 - BOMBAY DUCK
4CAX33000500 - CATFISH
4CAX33379100
4CDX33000500 - JEWFISH
4CDX33001100
4CDX33371900
4GPX33000500 - ROCK COD
4GPX33300000
4GRY33000900 - YELLOW CROAKER
4PCX33001100 - CONGER EEL
4PCX33379100
4SNA33000500 - RED SNAPPER
4TRI33000500 - LEATHERJACKET
4MUL34000500 - MULLET
4BUX34120000 - POMFRET
4POB34000500 - BLACK POMFRET
4SIP34000500 - WHITE POMFRET
4THF34379100 - INDIAN SALMON FISHMAW
4TRE34000000 - HORSEMACKEREL
4HEP35375000 - HERRING ROE
4IOS35000000 - SARDINES
4IOS35000500
4ANX35000000 - GOLDEN ANCHOVY
4JAN35001000 - ANCHOVY
4STO35001000
4STO35125000
4FRI36001100 - FRIGATE
4FRI36444100
4KAW36000500 - KAWAKAWA
4KGX36000000 - SEERFISH
4SKJ36000100 - SKIPJACK
4SKJ36000200
4SKJ36000500
4SKJ36115500
4COM36000500 - KING MACKEREL
4MAX37121000 - MACKEREL
4RAG37119500
4DGX38000100 - DOGFISH
4DGX38371100

4SKH38371100 - SHARKSFIN
3SRX38000500 - SKATES/RAYS
4XXX44718100 - SEAHORSE
4DCP45000100 - SHRIMP
4DCP45401100
4DCP45410100
4DCP45440100
4ABX52510100 - ABALONE
4OYC53510000 - OYSTER
4SCX55551000 - SCALLOPS
4CTL57000500 - CUTTLEFISH
4CTL57000900
4CTL57000910
4CTL57720100
4SQC57000100 - SQUID
4SQC57000910
4SQC57121000
4SQC57504100
4SQC57504110
4TIX72000000 - TURTLE SHELL
4CUX75719100 - BECHE-DE-MER
4JEL76000000 - JELLYFISH
4JEL76000301
4XXXXX379100

Code No: 424HIL000000
Trade Name: DRIED HILSA
Species: Indian Shad, hiba shad
Scientific Name: Hilsa ilisha
Preservation Method: Dried
Product Form:
Grading/Count:
Primary Pack:
Master Carton:
Units:
Weight:
Type:

Code No: 425GIP379100
Trade Name: DRIED GIANT SEA PERCH FISHMAW
Species: Barramundi
Scientific Name: Lates calcarifer
Preservation Method: Dried
Product Form: Fishmaw
Grading/Count: 24 below, 25 above
Primary Pack: 4 kg, double gunny bag
Master Carton:
Units:
Weight:
Type: Gunny bag

Code No: 432ALK000910
Trade Name: DRIED POLLACK
Species: Prepared snack
Scientific Name:
Preservation Method: Dried
Product Form: Prepared snack (spiced & seasoned)
Grading/Count:
Primary Pack: 15kg
Master Carton: **Units:** 20x20x15
Weight:
Type:

Code No: 432ALK001000
Trade Name: DRIED POLLACK
Species: Alaska pollack
Scientific Name: Theragra Chalcogramma
Preservation Method: Dried
Product Form: With head
Grading/Count:
Primary Pack: 10 kg, carton-box/bag
Master Carton: **Units:**
Weight:
Type:

Code No: 432ALU230000
Trade Name: DRIED POLLACK
Species: Alaska pollack
Scientific Name: Theragra chalcogramma
Preservation Method: Dried
Product Form: Boneless, skinless, fillets
Grading/Count:
Primary Pack:
Master Carton: **Units:**
Weight:
Type:

Code No: 433DPC000000
Trade Name: DRIED CONGEREEL
Species: Daggertooth pike-conger
Scientific Name: Muraenesox cinereus
Preservation Method: Dried
Product Form:
Grading/Count:
Primary Pack:
Master Carton: **Units:**
Weight:
Type:

Code No:	433BUC000100
Trade Name:	DRIED BOMBAY DUCK
Species:	
Scientific Name:	Harpodon nehereus
Preservation Method:	Dried
Product Form:	
Grading/Count:	
Primary Pack:	
Master Carton:	Units:
	Weight: 20 kg
	Type: Gunny bag

Code No:	433CAX000500
Trade Name:	DRIED CATFISH
Species:	
Scientific Name:	Ariidae
Preservation Method:	Salted and dried
Product Form:	
Grading/Count:	400 grams to 3 kgs
Primary Pack:	
Master Carton:	Units:
	Weight:
	Type:

Code No:	433CAX379100
Trade Name:	DRIED CATFISH MAWS
Species:	
Scientific Name:	Ariidae
Preservation Method:	Dried
Product Form:	Fishmaw
Grading/Count:	30-50 pc/kg
Primary Pack:	
Master Carton:	Units:
	Weight: 32kg, 40-120kg
	Type: double gunny bag

Code No:	433CDX000500
Trade Name:	SALTED & DRIED JEWFISH
Species:	
Scientific Name:	Sciaenidae
Preservation Method:	Salted & dried
Product Form:	
Grading/Count:	
Primary Pack:	
Master Carton:	Units:
	Weight: 25kg
	Type: Corrugated card board carton

Code No: 433CDX001100
Trade Name: DRIED JEWFISH
Species:
Scientific Name: Sciaenidae
Preservation Method: Dried
Product Form: Round
Grading/Count: 6 pc/kg
Primary Pack:
Master Carton:
Units:
Weight: 25kg
Type: Jutebag

Code No: 433CDX379100
Trade Name: DRIED JEWFISH MAW
Species:
Scientific Name: Sciaenidae
Preservation Method: Dried
Product Form: Fishmaw
Grading/Count: 4-8 oz/pc, U12, 13-24, 25 up pc/kg
Primary Pack:
Master Carton:
Units:
Weight: 25/50kg, 90kg
Type: double gunny bag

Code No: 433GPX000500
Trade Name: DRIED ROCK COD
Species: Groupers nei
Scientific Name: Epinephelus spp
Preservation Method: Salted & dried
Product Form:
Grading/Count: 400 gms to 2 kg
Primary Pack:
Master Carton:
Units:
Weight:
Type:

Code No: 433GPX300000
Trade Name: DRIED ROCK COD
Species: Groupers nei
Scientific Name: Epinephelus spp
Preservation Method: Dried
Product Form: Boneless, split
Grading/Count:
Primary Pack:
Master Carton:
Units:
Weight:
Type:

Code No: 433GRY000900
Trade Name: DRIED YELLOW CROAKER
Species: Greater yellow croaker
Scientific Name: Pseudosciaena crocea
Preservation Method: Dried & salted
Product Form:
Grading/Count:
Primary Pack:
Master Carton: Units:
Weight:
Type:

Code No: 433PCX001100
Trade Name: DRIED CONGER EEL
Species:
Scientific Name: Muraenesox spp
Preservation Method: Dried
Product Form: Round
Grading/Count: 6 pc/kg
Primary Pack:
Master Carton: Units:
Weight: 25kg
Type: Jutebag

Code No: 433PCX379100
Trade Name: DRIED CONGER EEL FISHMAWS
Species:
Scientific Name: Muraenesox spp
Preservation Method: Dried
Product Form: Fishmaw
Grading/Count: U30, 31-45, 41 up pc/kg
Primary Pack:
Master Carton: Units:
Weight: 25kg, 40kg
Type: double gunny bag

Code No: 433SNA000500
Trade Name: DRIED RED SNAPPER
Species: Dried snapper
Scientific Name: Lutjanus spp
Preservation Method: Salted & dried
Product Form:
Grading/Count:
Primary Pack:
Master Carton: Units:
Weight:
Type:

Code No: 433TRI000500
Trade Name: DRIED LEATHERJACKET
Species: Triggerfishes
Scientific Name: Balistes spp
Preservation Method: Salted and dried
Product Form:
Grading/Count: 800 grams to 4 kg
Primary Pack:
Master Carton: Units:
Weight:
Type:

Code No: 434MUL000500
Trade Name: DRIED MULLET
Species: Mullets nei
Scientific Name: Mugilidae
Preservation Method: Salted and dried
Product Form:
Grading/Count: 400 grams to 1 kg
Primary Pack:
Master Carton: Units:
Weight:
Type:

Code No: 434BUX120000
Trade Name: DRIED POMFRET
Species:
Scientific Name:
Preservation Method: Dried
Product Form: Splitted
Grading/Count:
Primary Pack: 10 lbs, Polythine wrapped
Master Carton: Units:
Weight: 50 lbs
Type:

Code No: 434POB000500
Trade Name: DRIED BLACK POMFRET
Species:
Scientific Name: Formio niger
Preservation Method: Salted and dried
Product Form:
Grading/Count:
Primary Pack: In mats
Master Carton: Units:
Weight: 50 kgs
Type: Jute bag

Code No:	434SIP000500
Trade Name:	DRIED WHITE POMFRET
Species:	Silver pomfret
Scientific Name:	Pampus Argentus
Preservation Method:	Salted and dried
Product Form:	
Grading/Count:	
Primary Pack:	In mats
Master Carton:	Units:
	Weight: 50 kgs
	Type: Jute bag

Code No:	434THF379100
Trade Name:	DRIED INDIAN SALMON FISHMAW
Species:	
Scientific Name:	Polynemidae
Preservation Method:	Dried
Product Form:	Fishmaw
Grading/Count:	4-8 pc/kg
Primary Pack:	
Master Carton:	Units:
	Weight: 25-50 kg
	Type: double gunny bag

Code No:	434TRE000000
Trade Name:	DRIED HORSEMACKEREL
Species:	
Scientific Name:	Caranx spp
Preservation Method:	Dried
Product Form:	
Grading/Count:	
Primary Pack:	
Master Carton:	Units:
	Weight:
	Type:

Code No:	435HEP375000
Trade Name:	SALTED HERRING ROE
Species:	Pacific herring
Scientific Name:	Clupea pallasi
Preservation Method:	Salted
Product Form:	Roe
Grading/Count:	
Primary Pack:	18kg
Master Carton:	Units: 1x18
	Weight:
	Type: Plastic

Code No: 435IOS000000
Trade Name: DRIED SARDINES
Species: Indian oil sardines
Scientific Name: Sardinella longiceps
Preservation Method: Dried
Product Form:
Grading/Count:
Primary Pack:
Master Carton: Units:
Weight:
Type:

Code No: 435IOS000500
Trade Name: DRIED SARDINES
Species: Indian oil sardines
Scientific Name: Sardinella longiceps
Preservation Method: Cured with salt and dried
Product Form:
Grading/Count: Above 7 cm
Primary Pack: 50 kg, Palm mat and sound gunnies
Master Carton: Units:
Weight:
Type:

Code No: 435ANX000000
Trade Name: DRIED GOLDEN ANCHOVY
Species: Anchovies nei
Scientific Name: Engraulidae
Preservation Method: Dried
Product Form:
Grading/Count:
Primary Pack:
Master Carton: Units:
Weight:
Type:

Code No: 435JAN001000
Trade Name: DRIED ANCHOVY
Species: Japanese anchovy
Scientific Name: Engraulis japonicus
Preservation Method: Dried
Product Form:
Grading/Count:
Primary Pack: 10 kg
Master Carton: Units:
Weight:
Type:

Code No: 435ST0001000
Trade Name: DRIED ANCHOVY
Species: "Stolephorus" anchovies
Scientific Name: Stolephorus spp
Preservation Method: Dried
Product Form:
Grading/Count: 4 - 6 cm
Primary Pack: 1/2 kg, sealed plastic pack
Master Carton:
Units:
Weight:
Type:

Code No: 435ST0125000
Trade Name: DRIED ANCHOVY
Species: "Stolephorus" anchovies
Scientific Name: Stolephorus spp
Preservation Method: Dried
Product Form: Head and boneless
Grading/Count:
Primary Pack: 100 x 8 oz, packed in plastic bags & cartons
Master Carton:
Units:
Weight: 50 lbs
Type:

Code No: 436FRI001100
Trade Name: DRIED FRIGATE TUNA
Species:
Scientific Name: Auxis thazard
Preservation Method: Dried
Product Form: Whole
Grading/Count:
Primary Pack:
Master Carton:
Units:
Weight: 26kg
Type: Corrugated card board carton

Code No: 436FRI444100
Trade Name: DRIED FRIGATE TUNA
Species:
Scientific Name: Auxis thazard
Preservation Method: Dried
Product Form: Broken (pieces of meat)
Grading/Count:
Primary Pack:
Master Carton:
Units:
Weight: 26kg
Type: Corrugated card board carton

Code No: 436KAW000500
Trade Name: DRIED KAWAKAWA
Species: Tuna
Scientific Name: Euthynnus affinis
Preservation Method: Salted & dried
Product Form:
Grading/Count: 1 to 3-1/3 kg
Primary Pack:
Master Carton:
Units:
Weight:
Type:

Code No: 436KGX000000
Trade Name: DRIED SEERFISH (KING MACKEREL)
Species: Seerfishes nei
Scientific Name: Scomberomorus spp
Preservation Method: Dried
Product Form:
Grading/Count:
Primary Pack:
Master Carton:
Units:
Weight:
Type:

Code No: 436SKJ000100
Trade Name: DRIED TUNA, SKIPJACK
Species: Skipjack
Scientific Name: Katswonus pelamis
Preservation Method: Dried
Product Form:
Grading/Count:
Primary Pack:
Master Carton:
Units:
Weight: 50kg
Type: In jute gunny

Code No: 436SKJ000200
Trade Name: KATSUOBUSHI
Species: Smoked, dried, skipjack, yellowfin
Scientific Name: Katsowonus pelamis, Thunnus tonggol
Preservation Method: Dried smoked
Product Form:
Grading/Count: Small, large, medium
Primary Pack: Poly bags
Master Carton:
Units:
Weight: 15 kg, 20 kg
Type:

Code No: 436SKJ000500
Trade Name: DRIED SKIPJACK
Species: Tuna
Scientific Name: Katsowonus pelamis
Preservation Method: Salted & dried
Product Form:
Grading/Count: 1 to 2-1/2 kg
Primary Pack:
Master Carton: Units:
Weight:
Type:

Code No: 436SKJ115500
Trade Name: MALDIVE FISH (SALTED & DRIED TUNA)
Species: Skipjack, yellowfin
Scientific Name: Katswonus pelamis
Preservation Method: Cured with salt & dried
Product Form: Heads-off
Grading/Count: Above 25 cm
Primary Pack: 50 kg, packed in palm mat & sound gunnies
Master Carton: Units:
Weight:
Type:

Code No: 436COM000500
Trade Name: DRIED KING MACKEREL
Species: Narrow-barred king mackerel
Scientific Name: Scomberomorus commerson
Preservation Method: Salted & dried
Product Form:
Grading/Count: 2 to 7 kg
Primary Pack:
Master Carton: Units:
Weight:
Type:

Code No: 437MAX121000
Trade Name: DRIED MACKEREL
Species: Mackerels nei
Scientific Name: Scombridae
Preservation Method: Dried
Product Form: Split, head-on, tail-on
Grading/Count: 5-7 inc/pc
Primary Pack: 1/2 kilo, sealed plastic pack
Master Carton: Units: 2
Weight:
Type:

Code No: 437RAG119500
Trade Name: DRIED INDIAN MACKEREL
Species:
Scientific Name: Rastrelliger kanagurta
Preservation Method: Salt cured & dried
Product Form: G & G
Grading/Count: Above 10 cm
Primary Pack: 50 kg, Palm mat and sound gunnies
Master Carton: Units:
Weight:
Type:

Code No: 438DGX000100
Trade Name: DRIED DOGFISH MEAT
Species:
Scientific Name:
Preservation Method: Dried
Product Form: Meat
Grading/Count: No heads, no internals, no fins
Primary Pack: 800 gm, wrapped in cellophane paper
Master Carton: Units:
Weight:
Type:

Code No: 438DGX371100
Trade Name: DRIED DOGFISH FINS
Species: Dogfish sharks nei
Scientific Name: Squalidae
Preservation Method: Dried
Product Form: Fin
Grading/Count: 4 inch
Primary Pack: 50 kg
Master Carton: Units: 1
Weight:
Type:

Code No: 438SKH371100
Trade Name: DRIED SHARKSFIN
Species:
Scientific Name:
Preservation Method: Dried
Product Form: Fin
Grading/Count: U10, 10-20, 20-30, 30-40, 40 up cm long/pc
Primary Pack: Quality A/B/C/D
Master Carton: Units:
Weight: 40kg, 120kg
Type: Double gunny bags, PP sacks

Code No: 438SRX000500
Trade Name: DRIED SKATES/RAYS
Species: Skates and rays nei
Scientific Name: Rajiformes
Preservation Method: Salted and dried
Product Form:
Grading/Count: 500 grams to 4 kg
Primary Pack:
Master Carton:
Units:
Weight:
Type:

Code No: 444XXX718100
Trade Name: DRIED SEAHORSE
Species:
Scientific Name:
Preservation Method: Dried
Product Form: Whole
Grading/Count: 8 "up, 4" - 8", 4" below
Primary Pack: 20 kg, tea chest
Master Carton:
Units:
Weight:
Type: Tea chest

Code No: 445DCP000100
Trade Name: DRIED SHRIMP
Species:
Scientific Name:
Preservation Method: Dried
Product Form:
Grading/Count: Large, medium, small
Primary Pack: 30lb
Master Carton:
Units:
Weight: 30lb
Type: Corrugated card board carton

Code No: 445DCP401100
Trade Name: DRIED SHRIMP
Species:
Scientific Name:
Preservation Method: Dried
Product Form: Whole
Grading/Count: U8, U10, 11-15, 16-20, 21-25, 26-30, 31-35, 36-40, 41-45, 51-60, 61-70, 71-90 pc/lb
Primary Pack: 1.5kg
Master Carton:
Units: 6x1.5
Weight:
Type: Corrugated card board carton

Code No: 445DCP410100
Trade Name: DRIED SHRIMP
Species:
Scientific Name:
Preservation Method: Dried
Product Form: Headless
Grading/Count: U8, U10, 11-15, 16-20, 21-25, 26-30, 31-35, 36-40, 41-45, 51-60, 61-70, 71-90 pc/lb
Primary Pack: 1.5kg
Master Carton:
Units: 6x1.5
Weight:
Type: Corrugated card board carton

Code No: 445DCP440100
Trade Name: DRIED SHRIMP
Species:
Scientific Name:
Preservation Method: Dried
Product Form: Peeled
Grading/Count:
Primary Pack:
Master Carton:
Units:
Weight:
Type:

Code No: 452ABX510100
Trade Name: DRIED ABALONE
Species:
Scientific Name: Haliotis spp
Preservation Method: Dried
Product Form: Shucked whole (meat)
Grading/Count: 1-2, 2 up inch/pc
Primary Pack:
Master Carton:
Units:
Weight: 40kg
Type: Corrugated card board carton

Code No: 453OYC510000
Trade Name: DRIED OYSTER
Species: Cupped oyster
Scientific Name: Crassostrea spp
Preservation Method: Dried
Product Form:
Grading/Count:
Primary Pack: 3 kg
Master Carton:
Units: 10
Weight:
Type:

Code No: 455SCX551000
Trade Name: DRIED SCALLOPS
Species:
Scientific Name: Pectinidae
Preservation Method: Dried
Product Form: Shucked, whole (meat)
Grading/Count:
Primary Pack: 20 kg
Master Carton:
Units: 1
Weight: 20 kg
Type:

Code No: 457CTL000500
Trade Name: SALTED & PRESERVED CUTTLEFISH
Species:
Scientific Name: Sepia spp, sepiola spp
Preservation Method: Salted and dried
Product Form:
Grading/Count:
Primary Pack:
Master Carton:
Units:
Weight:
Type:

Code No: 457CTL000900
Trade Name: DRIED CUTTLEFISH
Species:
Scientific Name:
Preservation Method: Dried, salted
Product Form:
Grading/Count:
Primary Pack:
Master Carton:
Units:
Weight:
Type:

Code No: 457CTL000910
Trade Name: DRIED CUTTLEFISH
Species: Prepared snack
Scientific Name:
Preservation Method: Dried
Product Form: Prepared snack (spiced & seasoned)
Grading/Count:
Primary Pack: 8g x 24
Master Carton:
Units:
Weight:
Type:

Code No: 457CTL720100
Trade Name: DRIED CUTTLEFISH BONE
Species:
Scientific Name:
Preservation Method: Dried
Product Form: Bone (centre soft bone)
Grading/Count: 3-4, 4-6, 6-8, 8-12 in/pc
Primary Pack:
Master Carton:
Units:
Weight:
Type: Wooden box

Code No: 457SQC000100
Trade Name: DRIED SQUID
Species:
Scientific Name: Loligo spp
Preservation Method: Dried
Product Form:
Grading/Count: 3-6, 7-10, 11 up inch/pc (length)
Primary Pack: 2kg
Master Carton:
Units: 5x2
Weight: 25kg, 18kg
Type: Corrugated card board carton

Code No: 457SQC000910
Trade Name: DRIED SQUID
Species: Tidbits/snacks
Scientific Name:
Preservation Method: Dried
Product Form: Tidbits/snacks
Grading/Count:
Primary Pack:
Master Carton:
Units:
Weight: 30 kg
Type:

Code No: 457SQC121000
Trade Name: DRIED SQUID
Species:
Scientific Name: Loligo spp
Preservation Method: Dried
Product Form: Split
Grading/Count: Small 3" - 5", Medium 6" - 9", Large 10" - 14"
Primary Pack: 1/2 kilo, sealed
Master Carton:
Units: 20
Weight:
Type: Corrugated card board carton

Code No:	457SQC504100
Trade Name:	DRIED SQUID
Species:	
Scientific Name:	Loligo spp
Preservation Method:	Dried
Product Form:	Skinless, head-on (kensaki)
Grading/Count:	LLL, LL, L, M, S, SS, SSS
Primary Pack:	10kg
Master Carton:	**Units:** 1x10
	Weight:
	Type:

Code No:	457SQC504110
Trade Name:	ROASTED SQUID
Species:	
Scientific Name:	Loligo spp
Preservation Method:	Roasted
Product Form:	Skinless, head-on (Yakiken)
Grading/Count:	M, S, SS, SSS
Primary Pack:	500g
Master Carton:	**Units:** 20x500
	Weight:
	Type:

Code No:	472TIX000000
Trade Name:	DRIED TURTLE SHELL
Species:	Marine tustles nei
Scientific Name:	Chelonia
Preservation Method:	
Product Form:	
Grading/Count:	
Primary Pack:	
Master Carton:	**Units:** 10
	Weight:
	Type: Wood

Code No:	475CUX719100
Trade Name:	DRIED BECHE-DE-MER
Species:	Sea Cucumber
Scientific Name:	Holothurioidea
Preservation Method:	Dried
Product Form:	Whole, gutted
Grading/Count:	U2, 2-3, 3-4, 4-5, 6 up inch/pc
Primary Pack:	
Master Carton:	**Units:**
	Weight: 30kg, 150lb, 100kg, 50kg
	Type: Lined Jutebag

Code No: 476JEL000000
Trade Name: DRIED JELLYFISH
Species:
Scientific Name: Rhopilema spp
Preservation Method: Dried
Product Form:
Grading/Count: A & B
Primary Pack: 30 kg
Master Carton:
Units:
Weight: 33 kg
Type:

Code No: 476JEL000301
Trade Name: SALTED JELLYFISH
Species:
Scientific Name: Rhopilema spp
Preservation Method: Salted and dried
Product Form: Sliced
Grading/Count:
Primary Pack:
Master Carton:
Units:
Weight:
Type:

Code No: 4XXXXX379100
Trade Name: DRIED FISHMAW
Species: Catfish, Eel, Indian Salmon, Jewfish
Scientific Name:
Preservation Method: Dried
Product Form: Fishmaw
Grading/Count:
Primary Pack:
Master Carton:
Units:
Weight:
Type: Gunny bag

PRODUCTION OF DRIED FISH IN THE EAST COAST OF PENINSULAR MALAYSIA - A SURVEY

by

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ABSTRACT

A survey was undertaken to study the status of the dried fish processing industry in the East Coast states of Kelantan and Trengganu. Ten districts were visited. Overall, most fish were processed in the months of August, September and October for processors in Trengganu, and in the months of March to October in Kelantan. The quantity processed per batch differed considerably: in Kelantan 83.3% of processors processed about 300 kg of fish and the rest in the range 301-1 200 kg, whereas in Trengganu, 20.8% processed under 300 kg, 51.9% processed from 300-1 200 kg and the others dealt up to 6 000 kg of fish. The type of fish commonly processed in both states were sardines (*Sardinella* sp.), anchovies (*Stolephorus commersonii*), jewfish (*Sciaena* sp.), selar scad (*Selar* sp.).

The paper also noted the quality of characteristics of dried fish identified by the processors. Important characteristics in determining the quality of dried fish include saltiness, appearance, colour, dryness and aroma. Most processors agreed that freshness of fish before processing is a very important factor in producing good quality dried fish.

Problems faced by processors in processing, storing and distributing the products were also looked into. Identification of these problems decides whether any improvement in processing and drying technology can be achieved.

INTRODUCTION

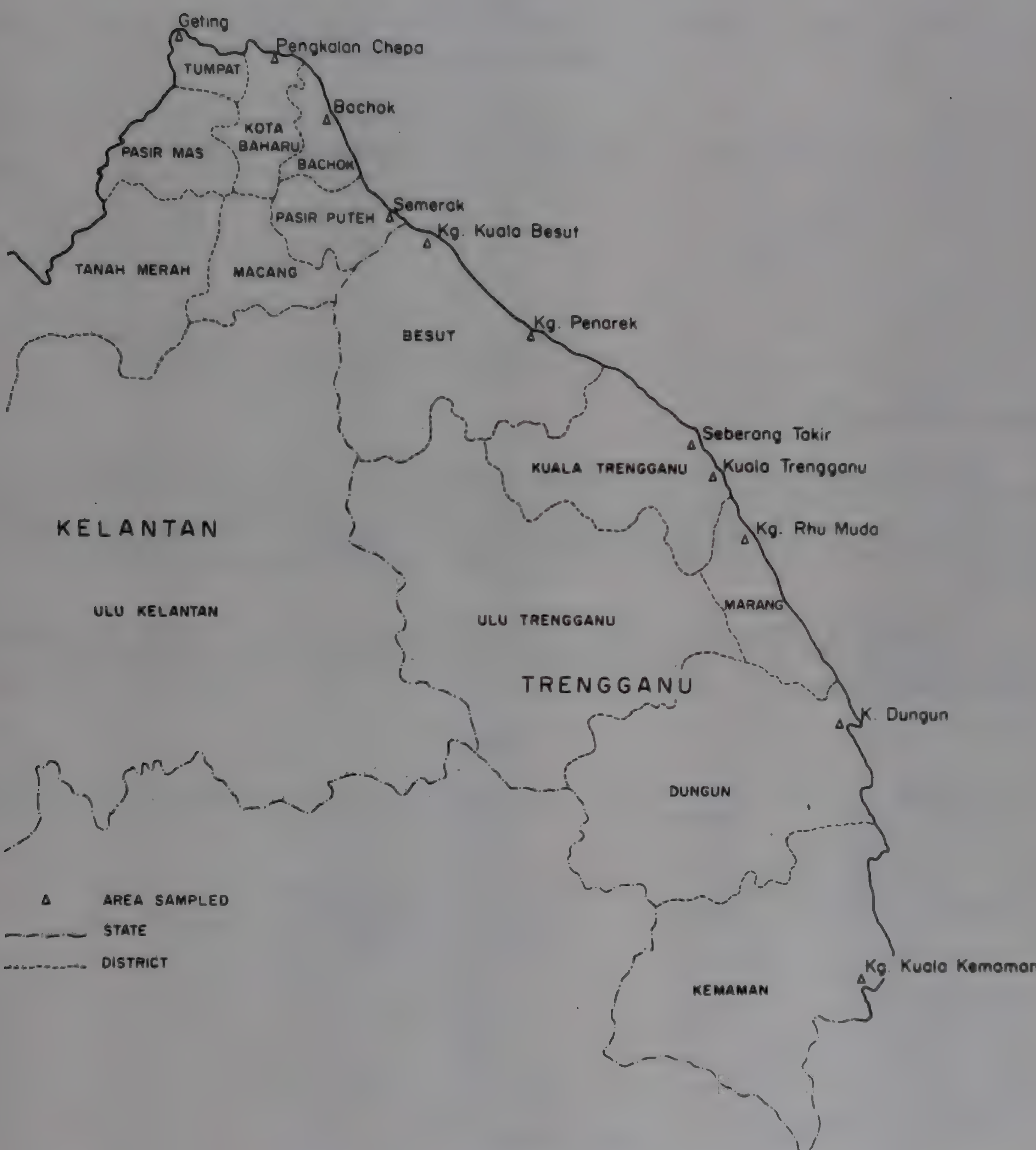
In 1980, 75 438.8 t or 12.09% of the total fish landed (623 896 t) in Peninsular Malaysia were processed. Fish meal and fish used for manure represented the bulk of processed fish while 10.6% where processed into dried fish and another 12.5% into dried anchovies. The breakdown on all the fish processed are presented in Table 1.

A survey on the dried fish industry was undertaken in the East Coast States of Kelantan and Trengganu in West Malaysia, to study the present status of the industry in these two states. These studies will be instrumental in helping to decide on certain parameters necessary to set up artificial fish dryers in these areas. In order to design these dryers, local conditions have to be studied. The survey therefore, should reveal the production capacity of dried fish in each district, the months in which most processing is carried out, etc. The distribution of dried fish and the problems associated with processing were also looked into.

METHODOLOGY

The survey was carried out by interviewing the processors usually at the actual drying sites, by using a questionnaire. Drying is usually carried out at fishing villages, and the areas sampled are shown in Map 1. A total of 184 processors were interviewed. They were asked the size of their production, the type of fish dried and in which month they are most busy and the production pattern in each month. They were also asked to state the

MAP I. KELANTAN AND TRENGGANU



characteristics of the good as well as bad quality fish. The problems encountered in processing, marketing and storing dried fish were also looked into, and lastly suggestions were invited from the processor on how to improve the present methods of processing (Appendix 2).

NUMBER OF PROCESSORS BY RACE

The majority of the processors on the East Coast were found to be Malays, with only a few Chinese. The distribution by state and race is shown in Table 1.

Table 1

Number of processors

State/race	Kelantan	Trengganu	Total
Malay	76	86	162
Chinese	2	20	22
Indian	-	-	-
Total	78	106	184

PRODUCTION CAPACITY

The data was collected by district in each of five districts surveyed in Kelantan and Trengganu. The range of quantity was specified and the frequency under each district was noted. It was found that most processors in Kelantan were small processors, 34.6% of processors dried under 100 kg of fish per baton and 48.7% processed 101-300 kg of fish (Table 2).

In Trengganu, 20.8% were small processors (under 300 kg of fish), 34.0% were medium processors (301-900 kg of fish) and 18.0% were processing between 101-1 200 kg. The complete distribution is shown in Table 3.

Table 2

Quantity of fish processed per batch for processors in Kelantan by number of processors in each fisheries district

Quantity of fish kg	Tawang	Pasir putih	Pengkalan chepa	Bachok	Tumpat	Total
below 100 kg	-	1	9	17	-	27
101-300 kg	16	4	8	4	6	38
301-600 kg	-	1	-	-	7	8
601-900 kg	-	-	-	-	3	3
901-1 200 kg	-	-	-	-	1	1
1 201 kg and above	-	1	-	-	-	1
Total	16	7	17	21	17	78

DISTRIBUTION PATTERN IN EACH MONTH

Production by month was tabulated and produced in graphical form. Overall, most fish were processed in the months of August, September and October for processors in Trengganu and in the months of March to October in Kelantan. Quantities of fish processed differs considerably - the two states, Trengganu processed up to 300 kg per month per processors,

while Kelantan processed only up to 700 kg per month per processors (Table 4 and Table 5).

Table 3

Quantity of fish processed per batch for processors in Trengganu by number of processors in each fisheries district

Quantity of fish	Kuala Trengganu	Marang	Kemaman	Besut	Dungun	Total
below 100 kg	-	-	-	4	-	4
101-300 kg	9	-	-	9	-	18
301-600 kg	1	8	-	6	5	20
601-900 kg	-	7	1	2	6	16
901-1 200 kg	1	10	1	6	1	19
1 201-1 500 kg	-	2	-	-	-	2
1 501-1 800 kg	3	-	-	4	-	7
1 801-3 000 kg	2	-	-	4	-	6
3 001-6 000 kg	-	-	9	2	-	11
6 001 kg and above	-	-	2	1	-	3
Total	16	27	13	38	12	106

Table 4

Quantity of fish used for the production of dried fish by month and by number of processors

Month	Number of processors	Quantity of fish total (kg)	%	Average kg/processor
January	-	-	-	-
February	2	2 057	0.37	1 028
March	7	5 808	1.04	829 ± 779
April	8	7 623	1.36	953 ± 667
May	8	5 112	0.91	639 ± 557
June	4	756	0.14	189 ± 387
July	19	18 114	3.24	953 ± 520
August	83	181 228	32.41	2 183 ± 657
September	90	198 990	35.59	2 210 ± 623
October	48	135 610	24.25	2 825 ± 802
November	3	3 267	0.58	1 089 ±1 457
December	1	605	0.11	605
Total		559 170		

Type of Fish Dried

The most popular fish processed were sardines (*Sardinella* spp.), jewfish (*Sciaena johnius* spp.), selar scad (*Selar* spp.), goatfish (*Upeneus* spp.), Indian mackerel (*Rastrelliger kanagurta*) and anchovies (*Anchoviella* spp.), Tables 6 and 7 give the quantities used for each process.

Table 5

Quantity of fish used for the production of dried fish
by month and by number of processors in Kelantan

Month	Number of processors	Quantity of fish		Average kg/processor
		Total kilograms	%	
January	47	7 466	2.27	159 ± 48
February	51	14 647	4.47	287 ± 142
March	72	26 650	8.13	370 ± 41
April	74	34 055	10.40	454 ± 47
May	74	36 457	11.13	538 ± 66
June	71	44 062	13.45	620 ± 87
July	71	57 049	15.58	688 ± 142
August	71	37 734	11.52	531 ± 79
September	70	31 375	9.58	448 ± 68
October	70	23 102	7.05	330 ± 43
November	57	12 221	3.75	240 ± 42
December	50	8 797	2.69	178 ± 31
Total		327 609	100.00	

Table 6

Trengganu: total number of processors interviewed: 106
Quantity of fish used for production of dried fish by type
and by number of processors

Type of fish: Local name	English name	Number of processors	Quantity of fish: Total kg	Average kg/batch/processor
tamban	sardine	97	22 504	232
gelama	jewfish	67	20 904	312
selar	selar scad	77	18 172	236
biji nangka	goatfish	53	16 430	310
kembung	Indian mackerel	78	15 756	202
bilis	anchovies	44	10 472	238
merah	red snapper	32	3 552	111
duri	marine catfish	7	2 813	402
lolong	gold banded scad	10	2 450	245
yu	shark	27	2 360	87.4
talang	queenfish, leather jacket, leatherskin	11	1 301	118
pari	ray	13	1 210	93
kerisi	threadfin bream	3	666	222
cincaru	hardtail scad	4	393	98.3
selayang	round scad	2	24.2	121
Total		106	119 225	-

Table 7

Kelantan: total number of processors interviewed: 78
Average quantity of fish used for dried fish production
by type and by the number of processors

Type of fish: Local name	Type of fish: English name	Number of processors	Quantity of fish: Total	Quantity of fish: Average capacity/ Processor kg/batch/processor
tamban	sardine	63	16 740	266
selar	selar scad	70	14 139	201
bilis	anchovies	15	9 378	635
pelata	scad	30	9 378	312
gelama	jewfish	26	4 096	157
selayang	round scad	18	2 390	132
merah	red snapper	2	1 997	988
lolong	gold banded scad	4	1 089	272
biji nangka	goatfish	2	1 028	514
kembung	Indian mackerel	1	121	121
duri	marine catfish	1	60.5	60.5
rambai	horse mackerel; travelly	1	60.5	60.5
total		78	60 477	-

Most of the fish used were marine fishes. All respondents in Kelantan caught their own fish and used it for processing, and some respondents in Tumpat supplemented their production by buying fish from Thailand, Kota Bharu and Kedai Buloh. While in Trengganu, most processors are also boat-owners, with quite a number of fishermen working under each processors. Fish used for processing are those caught by his own fishermen (Table 8).

Table 8

Source of supply of fresh fish

Source/state	Trengganu (%)	Kelantan (%)
1. Own catch and/or from local fishermen	92.28	100%
2. Thailand	-	19.23
3. Kota Bharu	-	20.51
4. Kedai Buloh	-	12.82
5. Majuikan	0.94	-

Distribution of Dried Fish

Processors in Kelantan normally cater for local markets, that is in Kelantan itself as well as the rest of Malaysia. Processors in Trengganu, sell direct to wholesalers who distribute the fish for the domestic market and export (Table 9).

Characteristics of a Good Quality Dried Fish

Respondents were asked what constituted a good quality dried fish. Processors in both states agreed that quality dried/salted fish must be prepared from fresh fish, i.e., where no freezing was occurred. The dried product should not be very salty or very dry. Other qualities are tabulated (Table 10), with percentage responses from the processor.

Table 9

Market distribution

State/ distributing channel	Trengganu %	Kelantan %
Chinese wholesalers from Kuala Trengganu, Dungun, Kota Bharu. (for local and overseas market)	64.15	87.18
Retailers (local market)	29.25	37.18
Own shops	20.75	-
Kuala Lumpur	15.09	2.56
Johor Bharu	-	2.56
Kuantan	-	1.28
Own consumption	5.66	-

Table 10

Characteristics of good quality dried fish

State/ characteristics	Trengganu %	Kelantan %
Origin: fresh fish	89.6	96.1
Not very salty	75.5	84.6
Not very dry	60.4	64.1
Give a rich taste	55.7	57.7
Fish meat are soft	0.9	79.5
No scratchy effect	-	64.1
No unpleasant odour	84.0	14.1
No maggot present	63.2	-
Fish is not beheaded	16.0	10.3

Some of the Problems Associated with the Production of Dried Fish

(i) Processing

About 66.0% of respondents in Trengganu felt that the preparation prior to drying such as eviscerating and cleaning, was time consuming and suggested that some mechanization should be introduced.

Shortage of labour was a problem to 33.0% and 6.4% of respondents in Trengganu and Kelantan respectively. This problem usually occurs during seasonal gluts. However, 80.8% and 19.8% of respondents in Kelantan and Trengganu respectively did not experience any problems (Table 11(a)).

(ii) Marketing

Low market demand for dried fish was a major problem faced by 62.3% of respondents in Trengganu but only 6.4% for Kelantan respondents. The market difference is due to the large output by Trengganu producers which not only caters for local markets but also other towns in Malaysia and abroad. With regard to prices, these are usually low when dried fish is plentiful, producers having to face the problem of getting rid of their products at reasonable price as the cost of renting cold rooms to keep the dried fish is quite expensive. Prices are also controlled by Chinese (middlemen) traders, who normally buy the

fish and sell it outside Kelantan or Trengganu. The dependency on Chinese traders is probably due to lack of transport. This is more apparent for processors in Kelantan (Table 11(b)).

(iii) Storage

Proper storage is needed before the dried fish is released to the consumers. Processors usually do not have any storage facilities so they either sell the products as soon as these are dried or those who can afford it, store them in cold rooms. Storage is needed in order to hold the goods until the price is reasonable, usually when no drying is carried out in the rainy seasons (Table 11 (c)).

(iv) Supplies of raw materials

Production of dried fish depends on the availability of fresh fish. During seasonal gluts fresh fish is cheap, so production of dried fish is carried out. Getting content supplies of fish is a problem to 43.3% of respondents in Trengganu. As there are large numbers of ice factories near landing sites, fresh fish can be kept for longer time and is able to reach interior markets. The price of salt has gone up due to shortages and this is felt by 28.2% of respondents in Kelantan (Table 11 (d)).

(v) Others

The traditional open air drying exposes the products to rain and wind which causes repeated wetting and redrying. In the monsoon season in November, December and January (in the East Coast), hardly any drying is possible.

Lack of capital and poor knowledge in business and marketing also hinder progress in dried fish industry (Table 11 (e)).

Table 11

(a) Processing

State/problem	Trengganu %	Kelantan %
No problem	19.8	80.8
Shortage of labour cleaning and drying procedure were time	33.0	6.4
Consuming	66.0	-
Presence of maggot	64.2	-

(b) Marketing

State/problem	Trengganu %	Kelantan %
No problem	34.0	25.6
Price was low, unstable and payment was late	40.6	60.0
Low demand for dried fish	62.3	6.4
Lack of transport	22.6	48.3
Monopoly by Chinese	30.2	-

Table 11 (Cont'd)

(c) Storage

State/problem	Trengganu %	Kelantan %
No problem	35.8	-
Lack of cold rooms	35.8	-
Shelf-life not very long	21.7	-
No proper storage	-	41.0
Maggots	-	25.6

(d) Suppliers of raw materials

State/problem	Trengganu %	Kelantan %
No problem	16.0	55.1
Lack of fresh fish	13.2	7.7
Supplies of fresh fish not constant	43.3	-
Shortage of salt	4.0	28.2
Competition from other fishermen	9.4	-

(e) Miscellaneous

State/problem	Trengganu %	Kelantan %
Rainy/monsoon season no drying possible	56.6	55.1
Lack of knowledge in business and marketing	30.2	-
Lack of capital	33.0	-
No cooperation from Majuikan[a/]		

a/ Majuikan is Fish Development Board of Malaysia.

Suggestions for improvement

Suggestions were invited from the processors on how to improve the present method of processing. Problems of storage were raised frequently among processors in Kelantan, and the suggestion of having smoke houses was put forward. Trengganu's processors were not bothered about storage, probably due to the availability of cold rooms in this area, which the processors could afford to rent. Other suggestions were compiled in Table 12.

Table 12

Method of improving the quality of dried fish
by state and percentage of processors

Methods/state	Kelantan (%)	Trengganu (%)
Could not be improved	8.97	24.53
By having a proper store	85.90	-
By having a smoke house (especially during rainy season)	85.90	-
Salt must be proportional to fish and mixed thoroughly	-	62.26
Increase salt content	-	6.60
Wash thoroughly with clean water	-	3.77
Drying should be extended as long as possible	-	65.09
Cold rooms	3.85	-
Drying room	1.28	0.94
Avoid rain	-	56.60
By setting up cooperatives	1.28	-

APPENDIX 1

Processed Marine Fish Products in 1980 for Peninsular Malaysia

Type of products	Total quantity processed (in t)	%
Salted-dried fish	7 993.7	10.60
Dried anchovies	9 436.6	12.50
Boiled fish	6 394.1	8.50
Manure fish	11 770.4	15.60
Fish meal	328.91	43.60
Dried prawns	1 268.3	1.70
Prawn dust	90.7	0.10
Prawn paste	32.7	0.04
Shrimp paste	2 699.5	3.60
Fish crackers	636.7	0.80
Prawn crackers	32.0	0.04
Pickled prawn	24.8	0.03
Dried cuttlefish	200.2	0.30
Fermented anchovies	22.6	0.03
Jelly fish	308.0	0.40
Dried cockles	1 296.9	1.70
Other shellfish	339.6	0.50
Total	75 438.8	100.00

Source: Annual Fisheries Statistics, Department of Fisheries, Malaysia.

APPENDIX 2

Dried Fish Processing in Malaysia

Number: ____________

Questionnaire: Processors

1. Name of fisherman or firm:

____

____

2. Address: ____________________________

____

____

____

3. Financially aided by:

   1. Government ______________________

   2. Majuikan ______________________

   Others:

   a) ____________________________

   b) ____________________________

   c) ____________________________

4. Quantity of wet fish processed at each processing:

____

5. List the types of fish dried, their quantity, and month:

	Type of fish	Quantity	Month
a.	____________	____________	____________
b.	____________	____________	____________
c.	____________	____________	____________
d.	____________	____________	____________
e.	____________	____________	____________
f.	____________	____________	____________

6. Indicate which month and the quantity of fish mostly dried:

	Month	Quantity
a.	____________	____________
b.	____________	____________
c.	____________	____________

Question 6 (cont'd)

d. ______________ ______________

e. ______________ ______________

7. List the type of fish that are most popular among the folk in the fishing community:

Type of fish	Reasons
a. ______________	______________________________
b. ______________	______________________________
c. ______________	______________________________
d. ______________	______________________________
e. ______________	______________________________

8. List the types of fish which are not popular and state the reasons why.

9. List the characteristics of good quality dried fish:

10. List the characteristics of bad quality dried fish:

11. When is dried fish mostly consumed? Give reasons.

12. Where do you obtain your source of fish for drying?

13. How do you distribute your dried fish to the market and state any problems encountered?

14. How is the dried fish been stored?

15. What are the problems faced by the dried fish processors in the following?

    a. processing:

    b. marketing:

    c. storage:

    d. source of raw material:

    e. others:

16. State any other type of problems encountered apart from the above:

17. What are the reasons for drying the fish?

18. Can you draw a flow chart of how you processed your fish? (i.e., a flow chart of your dried fish production.)

19. The fish dried were considered:

    a. excellent ______________________

    b. good ______________________

Question 19 (cont'd)

c. average ____________________

d. bad ____________________

20. If the answer in (19) is (c) and/or (d), state the reasons why.

21. What are the methods of improving the quality of dried fish?

PRODUCTION OF SALTED AND DRIED FISH IN THE MALDIVES

by

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ABSTRACT

The fishing industry of the Maldives is in a state of transition. Among the "new" items to be produced and exported is salted and dried fish. A FAO consultant worked in the Maldives for three months in 1981-82 to help improve production and advise on storage and shipment. Although salted and dried fish may not be of crucial importance for the economy of the Maldives, it is likely that this product will be prepared for some time to come since the fresh fish collection system will not be able to cover all areas at all times and other preservation methods are less suitable. The quality of salted and dried fish can be improved significantly and most processors know how to make better quality products. However, the incentive to improve the quality is missing since the same price is paid for all quality grades at the present time. Most storage rooms for salted and dried fish in Male need improvement. Packaging of salted and dried fish is adequate but for shipping, exporters might consider refrigeration, especially with market diversification in mind. It is considered essential to introduce a quality grading system for salted and dried fish, supervised by Government inspection, that honours in price the difference in product quality. The outlines for such a grading system were drawn up together with a preliminary Code of Practice for the making of salted and dried fish. Small-scale salt production should be considered. Use of iron drums for salting must be eliminated.

INTRODUCTION

Fisheries has always been the main livelihood of the Maldivian people. For ages fishing was conducted from small sailing boats, "dhonis", by hook and line or trolling. The predominant species are skipjack tuna and juvenile yellowfin tuna. The traditional processing and preservation method was smoking and sun-drying of boiled, lightly salted tuna fillets. For centuries this was the only seafood export from the country but the trade was reduced during the last decade due to restriction of imports to Sri Lanka and lack of firewood for smoking at home.

Other very important changes have been taking place in the Maldive fishing industry during the last 10 years. One is the mechanization of the larger boats. Today, 70-80% of the catch is landed by "engine dhonis". Another is buying and collection of fresh fish for freezing aboard foreign freezing vessels. The third is production and export of salted and dried fish.

Export of salted and dried fish is not of major national importance. It is however important for some islands and some regions where the sale of fresh fish to collector vessels is not possible and it should be noted that only tuna are bought fresh. Therefore, the Maldivian Government, worred about low prices of salted and dried fish, asked for FAO assistance to improve the quality of such products in order to improve returns to the fishermen.

In the middle of 1981 a Technical Cooperation Project was signed and the author was recruited as a consultant to help to improve production and advise on storage and shipment. The main findings and recommendations are reported below.

PRESENT PRODUCTION METHODS AND STORAGE CONDITIONS

Three major expeditions were made to 21 fishery islands in 8 different atolls (island clusters) to observe salt fish production and to demonstrate and introduce improved processing techniques. The processing methods and the quality of the products varied significantly from one atoll to another, from island to island, and also within islands. There were sometimes striking differences between islands close to each other in the same atoll. In some instances local conditions prevented good processing where population was too dense, the space for drying racks was limited, there was a shortage of storage space, lack of water and poor hygienic conditions.

In general, fish is cut up, cleaned and salted almost immediately upon landing. Many processors follow the recommended practices reasonably well whereas others are less careful. There is a common tendency to use too little salt and to dry the fish for too short a time, both factors due to obvious economic reasons. People were rather reluctant to remove the backbone of the fish before salting and tended to use the same brine over and over again. It was encouraging to find the majority of processors using concrete vats (or wells) for brining and drying racks for drying. Brining time seemed to vary quite considerably as did washing of the fish before drying and general handling and storage after drying.

Some salted and dried fish is still produced on fishing boats or on uninhabited islands by fishermen far from their homes. In these cases iron drums are almost exclusively used for salting and they are also still used by some processors at home. It was observed that this ruins the quality (appearance) of the fish and it is essential that the use of iron drums be discontinued.

The receiving and storage conditions for salted and dried fish are poor in Male. Usually the storage rooms, which were designed for the hard dried Maldive fish, are small with no air circulation at all and not even cement floors. Some buyers, however, have their business in newer and better buildings on the waterfront in the reclaimed town area. Common to all is a shortage of space. Fish is stacked on the floor with some degree of insect infestation; there is very little possibility to keep different lots separated, so good quality and poor will almost inevitably be mixed. There is no possibility to store any greater amount of fish in Male at the time being, which may partly explain the great price fluctuations which are to the advantage of foreign importers.

The State Trading Organization (STO) has now completed two new storage warehouses on islands close to Male. These are concrete buildings, very spacious, reasonably well ventilated and should result in a great improvement of storage conditions.

Packaging is usually in 50 kg bundles, wrapped in hessian (canvas) and closed by stitching. This is the conventional method used in the salt fish trade all over the world and must be considered satisfactory for the Maldivian salt fish too.

Shipping of salted and dried fish from Maldives to Colombo is usually done by rather small wooden vessels, since steel vessels tend to get very hot on sunny days. The Customs Department inspects goods to be exported. A certain percentage of packs are opened, partly to make sure that the contents are in accordance with statements, but it is also possible for customs inspectors to condemn goods that are obviously of bad quality. However, this power does not seem to be extensively used.

DRAFT CODE OF PRACTICE FOR MAKING SALTED AND DRIED FISH IN THE MALDIVES

It was found that although very few, if any, producers follow the procedures listed below exactly, almost all of the points are used somewhere. An important observation made was that many producers admitted that the recommended procedures would result in improved quality, but there was no incentive to make better products since prices are the same for all quality classes. On the understanding that better prices would be obtained for better products a great majority of the producers would improve their processing methods.

One of the most serious mistakes made by producers is to use as little salt as possible. This problem is also difficult to deal with not only because of the price of salt but also due to the long distances and difficulties of transportation. It has been proposed to start salt distribution on a large scale by the Government or at least to encourage such an operation. A better solution would be to start small-scale salt production on suitable islands not too far apart from each other.

The following "Recommended Procedures" were translated into the native language, illustrated and distributed to fish processors around the country:

(a) Cleaning and cutting

(1) Clean and cut the fish as soon as possible after landing; never keep it overnight. Remove all intestines and wash off all blood, dust and sand in clean water or seawater.

(2) Remove about 2/3 (two-thirds) of the backbone and make 2-3 (depending on fish size) incisions (cuts, longitudinal) on each side of the fish, not cutting through the skin.

(b) Salting

(3) Use no less than one part of salt (medium/coarse) to 4-5 parts of fish (by weight or approximately 80 kg salt to 200 skipjack tuna). Sprinkle the salt on each fish or, better, rub it on.

(4) Use cement vats (wells) or plastic containers for brining, put weight on top of the fish and cover the vat. Do not use the same brine again but undissolved salt on the bottom of the vat can be re-used.

(5) Put large fish on the bottom and smaller on the top. One day and two nights in brine may be enough for small fish; very large fish (and shark) will need three days and four nights brining time, or more.

(c) Drying

(6) Wash off excess salt in the brine or wipe it off with wet cloth. Skin side of the fish should be facing the sun the first half or one day.

(7) Always dry fish on racks, about 1 m above the ground. Any design of drying racks that permits drying from both sides can be used.

(8) Stack fish up and cover with waterproof material at night and before rain starts.

(9) Dry the fish until it feels hard (cannot be compressed between two fingers). Small fish will need about three good days; large fish may need at least five days.

(d) Storage

(10) Store dried fish on platforms (pallets) 15-25 cm off the floor. Open doors and windows on sunny days. Re-dry half or one sunny day before selling.

(11) In storage rooms of exporters there should be good ventilation (fans) during daytime, fish should be kept on pallets, air passages left open at approximately 1 m intervals and insect and other pest control maintained as good as possible.

INSPECTION AND GRADING

As mentioned earlier it was thought useless to introduce or impose a code of production practices or even quality inspection on the producers without paying higher prices for better quality grades of fish. The idea of inspection and grading was discussed with a great number of producers and most people seemed to agree that product quality would improve immediately, if higher prices were paid for better quality grades. There was however an obvious mistrust and credibility gap between producers and buyers and it is hard to see that this will disappear or even diminish without government intervention.

The following ideas about quality, grading and inspection of salted and dried fish were developed during travels to fish processing islands and visits to warehouses of fish buyers in Male. These ideas were discussed with Government officials, fish buyers and producers with generally favourable reactions. However, much more work is needed before these guidelines can become a general practice.

To be accepted as Grade I quality salted and dried fish, the following conditions shall be met:

1. Fish should have no insects, larvae or moulds.

2. About two-thirds of the backbone should have been removed. Incisions (longitudinal cuts) shall be made through the thick muscle on each side before salting, without cutting through the skin. (Usually 2-3 cuts on each side).

3. Only minor damage to the skin and flesh should be observed with no pronounced discolourations.

4. No pieces of the intestines, blood or foreign matter (rust, paint, sand, wood, etc.) should be visible.

5. Salt content and moisture content should be within accepted limits. (Salt: 10-20%, moisture: below 40%). No salt crystals should be present on the surface. When properly dried the fish should be hard, that is it should not be possible to compress it between two fingers.

Fish not meeting the above standard shall be Grade II except:

(a) Fish severely damaged by insects or animals.

(b) Fish badly discoloured from rancidity or putrefaction.

(c) Fish with live insects, larvae or eggs in the flesh or covered with moulds, showing obvious flesh discolouration as a result.

(d) Fish with pronounced putrid odours.

Such fish with these deficiencies (a) to (d) shall be condemned and rejected both for export and domestic consumption.

INSPECTION

It is possible that the execution of the inspection and grading system becomes a major source of disagreement. There are several options that might be considered in this respect, but the following has been found to be generally acceptable to producers and buyers:

- Grading will usually be left to the buyer and seller in cooperation, based on an established and agreed code of practice.

- Sellers may wish to have their own representative present when a batch of fish is sold or each crew or individual may want to do this himself. In case of disagreement there must be a possibility to call a Government inspector who then rules in such cases and the parties will have to accept his ruling.

The main handicap of such a system is that it may not ensure good quality being exported as Grade I if there is a great demand on the market and the buyer is therefore willing to sacrifice quality for volume. There may also be constant disagreement and appealing to the Government inspector. Excessive use of a mechanism of appeal to the Government inspector can possibly be avoided by making a charge for this service.

FOLLOW-UP

As a result of this work, the Government of the Maldives has requested further assistance from FAO and it is expected that a project will start in November 1982. Initially, a training course of six weeks' duration will be held to train 12 Maldivian inspectors in grading and inspection procedures. The trainees will then be taken on a study tour of producing islands and warehouses to train them as extension workers. Investigation of production of solar salt for fishery purposes will be undertaken and, if successful, production facilities will be planned. Finally, after the inspection system has been functioning for some time a refresher course will be held for the inspectors.

THE FISH-CURING INDUSTRY IN INDIA

by

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ABSTRACT

The paper describes processing methods and dried fish products in India and gives details of improved methods resulting from Government research. Composition of some of the most popular products is given together with current Indian standards.

INTRODUCTION

With a 200-km exclusive economic zone around a coastline of more than 5 600 km, India has vast marine fishery resources. As a result of imaginative schemes implemented by the Government of India, since independence, marine fish landings have shown a phenomenal increase in the last decade. Increased landings bring in new problems of processing and preservation. In a country like India it is not easy to make fresh fish available in prime condition to the interior. Since a well organized cold chain is yet to be established, these interior parts still depend on cured fishery products for their supply of fish. Depending on the regional variations in taste and consumer preference, different types of cured products are popular in different parts of the country.

Sun Drying

The southwest coast had always been the major fish landing area in India. From very early times, before the advent of modern freezing and canning industries, sun drying had been a popular method of fish preservation along this coast. Oil sardine, mackerel, sole, white bait, silver bellies, etc., are traditionally sun dried on the sandy beach itself. This crude method naturally yields a poor product, contaminated with sand and dirt. Calicut on the southwest coast and Tuticorin on the southeast coast are major centres of dry fish production.

Saurashtra coast in the northwest also lands huge quantities of fish which are traditionally processed into dried products. Bombay duck (*Harpedon neherius*) is the major fishery of this region. This seasonal fishery, during the winter months of October-February, is quantitywise one of the most important species of fish landed in India. The peculiar composition of this fish, with about 90 percent moisture in its muscle, makes it unsuitable for other types of processing. Fishermen of this region have perfected an ingenuous method for sun drying this fish. Sharp-toothed jaws of two fish are interlocked and they are hung from rows of ropes tied to strong poles errected on the beach. The fish, sun-dried in the open in this way, is invariably attacked by flies, etc., though contamination with sand and dirt is minimum. In the winter months when humidity is very low (around 30% RH) drying is generally fast. However, the product looks unattractive and lacks consumer appeal. Nawabunder, Rajpara and Jaffrabad along the Saurashtra coast land substantial quantities of this fish. Besides Bombay duck, this region has vast resources of scianeids, ribbon fish (*Trichurus savala*), sharks, rays, etc., which are all species ideal for drying.

Dried prawn pulp was another major traditional dried fishery product of India. In the early fifties India produced sizeable quantities of dried prawn which was mainly exported to neighbouring countries such as Burma. With the advent of freezing and canning industries in the fifties, the dry prawn pulp industry died a natural death. Frozen prawns became an export item for Western markets.

Wet Curing (Colombo curing)

Oil sardines and mackerels were formerly preserved mainly by wet during methods. The Calicut region in the southwest coast evolved a special method of wet curing whereby fish was pickled in large wooden barrels using salt. Eviscerated fish was salted and stacked in these barrels with pieces of dried pods of malabar tamarind (*Garcinia cambogea*), in the belly cavity. The barrels were kept full with saturated brine and closed tight. The fish was transported in these barrels. The acidic ph of the tamarind juice, extracted into the brine, had a preservative effect. This fish had a characteristic flavour popular among the estate labourers of Sri Lanka who were its main consumers. As Colombo was the main market for this product, the method came to be known as Colombo curing. This has also become an obsolete method now.

Fishing and fish curing was traditionally an occupation taken up by the weaker sections of Indian society. So, after independence in 1947, the Government of India gave importance to schemes for improving the lot of these people. With this in view, the former Madras Government established a Fisheries Technological Laboratory at Calicut and in 1958, the Government of India established the Central Institute of Fisheries Technology (CIFT), with regional laboratories at important fish landing centres.

DEVELOPMENT OF IMPROVED METHODS

These laboratories conducted detailed surveys on the existing fish curing methods and devised new methods for the production of good quality cured fishery products. A method for producing semi-dried prawns was worked out. Lekshmy, Govindan and Pellai (1964), reported results of their detailed investigations on dried prawns. Balachandran and Bose (1964; 1965), tried different types of driers for producing dry prawn pulp. A rotary drum drier was found suitable for cooking, deshelling and drying the prawn in a single operation. Kaimal and Balachandran (1969), studied the various problems involved in drying of prawns.

For drying of fish, bamboo mats, or preferably raised platforms, are now popular to reduce contamination with sand and dirt. Artificial driers for fish were also developed by the Central Institute of Fisheries Technology. A hot air tunnel drier, designed and popularized by the Institute, has been found very convenient, reasonably cheap and easy to instal and operate in coastal villages; several driers of this type are now in operation. They are used to dry different types of fish; Chakraborty (1975; 1975a), has described the design and operational designs of this type of drier.

USE OF PRESERVATIVES

Technological investigations on the problems encountered in fish curing are conducted by the Central Institute of Fisheries Technology. As early as 1961 propionic acid was recommended as a preservative for wet and dry cured products. Later (Valsan, 1968), a modification was introduced. A dip treatment in 3 percent solution of sodium propionate, prior to salting and drying, was found very effective. Further work proved that dusting the salted and dried product with a mixture of sodium propionate and sodium chloride just before packing, was enough to ward off insects and mites as well as the red halophilic bacteria in cured fish. This is a cheap and effective method for producing good quality cured fish of long shelf life. Devadasan, Muralidharan and Joseph (1977), tried other preservatives for cured fishery products.

LAMINATION OF BOMBAY DUCK

Quantitywise, Bombay duck is the most important dry fish produced in India, but the traditional dry Bombay duck was an unattractive and unhygienic product. A process developed by the CIFT has changed the appearance and quality of the dried Bombay duck beyond recognition. Partially dried Bombay duck is split open, flattened and dried. After trimming the sides, the fish is packed as a fine laminated product. Drying is done in an artificial drier. This is a product of high quality and tremendous consumer appeal. Kandoran, Rao and Valsan (1967) and Prabhu (1972), have described the advantages of the process.

SMOKE CURING

Smoked products have not become very popular in India. Fish like eel, scianeids, oil sardine, mackerel, ribbon fish, etc., are found to give very good smoked products; but in spite of efforts to popularize these products, the smoked taste has not become very popular in India so far. A hard smoked and hard dried product prepared from tuna by an indigenous process is a popular product in the Union Territory of Lakshadweep, in the Arabian Sea. The product, traditionally called massmin, is a favourite export item from the islands to the Far East.

PACKING OF DRIED FISH

Packaging of dry fish is the weak point of curing industry in India. Modern methods of packaging have yet to be adopted by the fish curers. Alkathene-lined gunny bags for bulk storage and polyethylene covers for retail packing are being popularized, but a lot of improvement is still required.

Composition of major Indian food fishes and cured products of commerce prepared from them are represented in Table 1. The figures give a range of values for moisture, protein, fat and ash.

Table 1

Composition of some Indian food fishes and cured products of commerce prepared from them

Popular name	Scientific name	Composition of fresh fish				Composition of cured product		
		Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Moisture (%)	Salt (%)	Acid in-soluble ash(sand) (%)
Mackerel	*Rastrelliger kanagurta*	73-75	18-20	3-5	1-2	35-40	15-35	0.5-3
Bombay duck	*Harpedon neherius*	88-90	9-10	-	0.5-1			
Sole	*Cyanoglossus senifasciatus*	70-73	18-20	4-5	2-3	15-45	15-35	0.5-2.5
Silver belly	*Leiognathus insidator*	75-77	18-19	1-15	3-4	30-45	25-35	0.1-2
Ribbon fish	*Trichiurus savala*	74-76	20.22	-	1-2	35-45	30-35	0.1-1
Jewfish	*Scianeids* sp.	75-77	17-18	-	1-1.5	40-45	15-35	0.7-2.5
Shark	various species	73-75	20-22	-	1-1.5	40-45	15-35	0.7-2.5
Oil sardines	*Sardinella longiceps*	65-75	16-18	2-20	1-1.5	35-40	15-35	0.5-2

Table 2 gives the data on the export of cured fishery products from India with the list of major importing countries. The figures show that export of cured products is decreasing. However, domestic consumption continues to be high and importance of fish curing as a preservation method cannot be overemphasized.

The Government of India has brought out Indian Standards and Specifications for many commercially important cured fishery products. These are formulated by the research laboratories working in this field. Table 3 gives a list of such approved standards published so far.

Table 2

Export of cured fishery products from India

Major importing countries: Sri Lanka, Hong Kong, Malaysia, Singapore, UK, USA, Mauritius

Year		Dried fish	Dried prawn pulp	Sharkfin and fish maws
1970	Q:	7 269	1 486	282
	V:	18 368	8 361	5 998
1971	Q:	5 941	684	295
	V:	13 820	3 742	5 189
1972	Q:	3 478	139	294
	V:	7 971	1 380	6 027
1973	Q:	3 388	294	252
	V:	10 955	3 230	6 569
1974	Q:	1 748	116	259
	V:	6 658	1 426	8 464
1975	Q:	2 295	99	307
	V:	9 061	1 132	9 822
1976	Q:	4 668	36	268
	V:	17 341	385	15 294
1977	Q:	4 221	235	287
	V:	22 730	1 711	22 469
1978	Q:	6 311	4	423
	V:	32 135	75	34 676
1979	Q:	3 728	19	4 340
	V:	18 934	222	20 802
1980	Q:	4 340	124	332
	V:	20 802	1 349	32 526

Note: Q = quantity in t; V = value in Indian rupees '000
US$ 1 = I.Rs. 9 approximately

Source: Marine Products Export Development Authority, Cochin, India

Table 4 gives the general requirements of dried fish and shellfish as per these standards. However, these standards have not been enforced by any statutory regulations so far, as is done in the case of frozen products meant for export market.

In short, it can be said that curing is bound to be a favourable method of fish preservation in India at least for another one or two decades. As such, improving the quality of the cured product is a national necessity, for which no effort is spared.

Table 3

Indian standards on dried fish and shellfish

Name of specifications	Specification number and year of publication
Dried prawns (first revision)	IS 2345 - 1972
Dried white baits (*Anchoviella* sp.)	IS 2882 - 1964
Dried and laminated Bombay duck	IS 2884 - 1964
Dry salted mackerel	IS 4302 - 1967
Dry salted seer fish	IS 5198 - 1969
Dry salted shark	IS 5199 - 1969
Dry salted surai (tuna)	IS 5736 - 1970
Dry salted threadfin and dry salted jewfish (first revision)	IS 3850 - 1973
Dry salted catfish	IS 3851 - 1966
Dry salted leatherjacket (*Chorinemus* spp.)	IS 3852 - 1966
Dry salted horse mackerel (*Caranx* sp.)	IS 3853 - 1966
Dried sharkfin	IS 5471 - 1969
Fish maws	IS 5472 - 1967

Table 4

Requirements for dried fish and shellfish

Fish	Characteristics		
	Moisture % (max.)	Sodium chloride % (max.)	Acid insoluble ash % (max.)
White baits	20	2.5	7
Tuna	35	25	1.5
Prawn pulp	20	5	1
Dried Bombay duck	15	7.5	1
Laminated Bombay duck	15	6	1.5
Mackerel	35	25	1.5
Catfish	35	25	1.5
Threadfin	45	25	1.5
Jewfish	40	20	1.5
Leatherjacket	40	25	1.5
Horse mackerel	40	25	1.5
Shark	40	30	1.5
Seer	45	30	1.5
Sharkfin	10	-	1.5

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COMPARATIVE STUDY OF SOLAR AND SUN DRYING OF FISH

by

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ABSTRACT

During recent years, the use of solar dryers has been investigated as an improved method of drying fish in tropical developing countries. The purpose of this study was to construct and evaluate three types of natural convection solar dryers on one of the Galapagos Islands off Ecuador. The dryers investigated were a solar tent dryer, a solar cabinet dryer and a dryer with a separate solar collector and drying chamber (SCD dryer). Drying trials were conducted using commercially important local fish species. The performances of the dryers were compared with those of two sun drying methods: the local traditional practice of drying fish on the prevalent black lava rocks and drying fish on a sloping rack.

INTRODUCTION

Unless fish are preserved or processed in some way to retard spoilage, they will become putrid within a few hours of capture at the high ambient temperatures in tropical countries. Spoilage is caused by the action of enzymes (autolysis) and bacteria in the fish, and also chemical oxidation of the fat which causes rancidity.

Salting and drying, used on their own or in conjunction with each other, are traditional methods of preserving fish which have been used for centuries. Dried salted products are still very popular in parts of Africa, SE Asia and Latin America. Reducing the moisture content of fresh fish by drying to around 25%* will stop bacterial growth and reduce autolytic activity but the moisture content must be reduced to 15% to prevent mould growth. Salt retards bacterial action and aids the removal of water by osmosis. When fish are salted prior to drying, a final moisture content between 35% and 45% in the flesh, depending on the salt concentration, is often sufficient to inhibit bacteria.

Many fishermen in tropical countries spread fish on the ground, on rocks or on beaches to dry in the sun. Some fish processors use mats or reeds laid on the ground to prevent contamination of the fish by dirt, mud and sand. These traditional methods have many disadvantages and the use of raised sloping drying racks has been introduced in recent years as a simple but often effective improvement (Watanabe 1975). When drying on a rack, it is possible to obtain a cleaner product which is less accessible to domestic animals and pests. Higher drying rates are achieved due to better air circulation and the fish are protected from rain simply by covering the rack with a sheet of waterproof material.

However, sun drying still has many limitations when racks are used: long periods of sunshine without rain are required; drying rates are low; and, in areas of high humidity, it is often difficult to dry the fish to a low moisture content. Sun dried fish are often of low quality as a result of slow drying, insect damage and contamination from air-borne dust, etc. It is also often difficult to obtain a uniform product.

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* All salt and moisture contents in this paper are expressed on a wet weight basis.

The use of solar dryers has been investigated as an alternative to traditional sun drying in tropical developing countries (Szulmayer 1971; Doe et.al., 1977; Chakraborty 1978; Ismail 1980; Doe 1982). Solar dryers employ some means of collecting and concentrating solar radiation to achieve elevated temperatures and reduced relative humidities during drying. This results in increased drying rates, lower final moisture contents and higher quality products. Solar dryers are less susceptible to variations in weather, and they provide shelter from rain. Pests are discouraged from entering the dryers due to the high internal temperatures which can be lethal to those which do enter.

Many designs of solar dryers for use with agricultural and fisheries products have been developed; only a few of these have been used specifically with fish and, at the time that this study was planned, no direct comparative exercise had been published on the relative performance of any of the types available. It was with this objective that three types of solar dryer for drying of fish were constructed and operated simultaneously on Santa Cruz, one of the Galapagos Islands off Ecuador.

Solar dryers fall into two categories based on the mode of air flow through the dryer; natural convection or forced convection. Only the former type were studied because forced convection dryers require a source of motive power, e.g., electricity, to drive a fan. In many areas of tropical developing countries, motive power of any kind is either unavailable or unreliable and expensive; therefore, forced convection dryers would not be a practical proposition for the majority of artisanal fishermen in these areas.

This study was conducted during the period of production of dried salted fish in Ecuador, which occurs during the six months prior to Easter. In Ecuador, the fishermen in the Galapagos Islands are the major producers of dried salted fish but have problems with quality mainly as a result of inefficient drying due to adverse weather conditions.

EQUIPMENT AND METHODS

Three natural convection solar dryers were constructed and operated, and their performances compared with those of two sun drying methods. Each method is described below. To ensure similar loading and to simplify comparison of performance, drying racks or trays of approximately equivalent dimensions (1.8 x 0.6 m) were built within each of the solar dryers.

Solar dryers

Solar tent dryer: This type of dryer was developed by Doe et.al.,(1977) and initially tested in Bangladesh with fish. The Tropical Products Institute and many other workers (Doe 1982) have tested this dryer in Africa, SE Asia and Latin America for drying of various fish products and it has shown considerable promise.

A sketch of the dryer as built for this study is given in Figure 1. It consisted of plastic sheet stapled to a bamboo frame and took six man-hours to construct. Black polyvinyl chloride (PVC) was used for the base and clear ultra-violet resistant polyethylene for the sides and ends. The drying rack was built along one side using bamboo and black plastic mesh. Access to the rack was through a movable plastic flap forming half of one end of the tent. This differed in one important aspect from the original design (Doe, et. al., 1979): both sides were of clear plastic whereas the original dryer had clear plastic on the side facing the sun and black plastic on the opposite side. The working site for this study was almost exactly on the equator, and the path of the sun was virtually due East to due West during this period (April-May); therefore, it was considered that the slight increase in efficiency of solar collection provided by a side of black plastic would be more than offset by the reduction in the "greenhouse effect".

Solar radiation passes through the clear plastic sides and ends of the tent and is absorbed on the black plastic base. Air at the base is thereby heated and rises, thus inducing a draught within the tent. Openings at the base along both sides allow air to be drawn in; vents in the apex at both ends allow air to exhaust. Some control of the internal temperature, and air flow through the dryer, can be achieved by adjusting the height of the side openings.

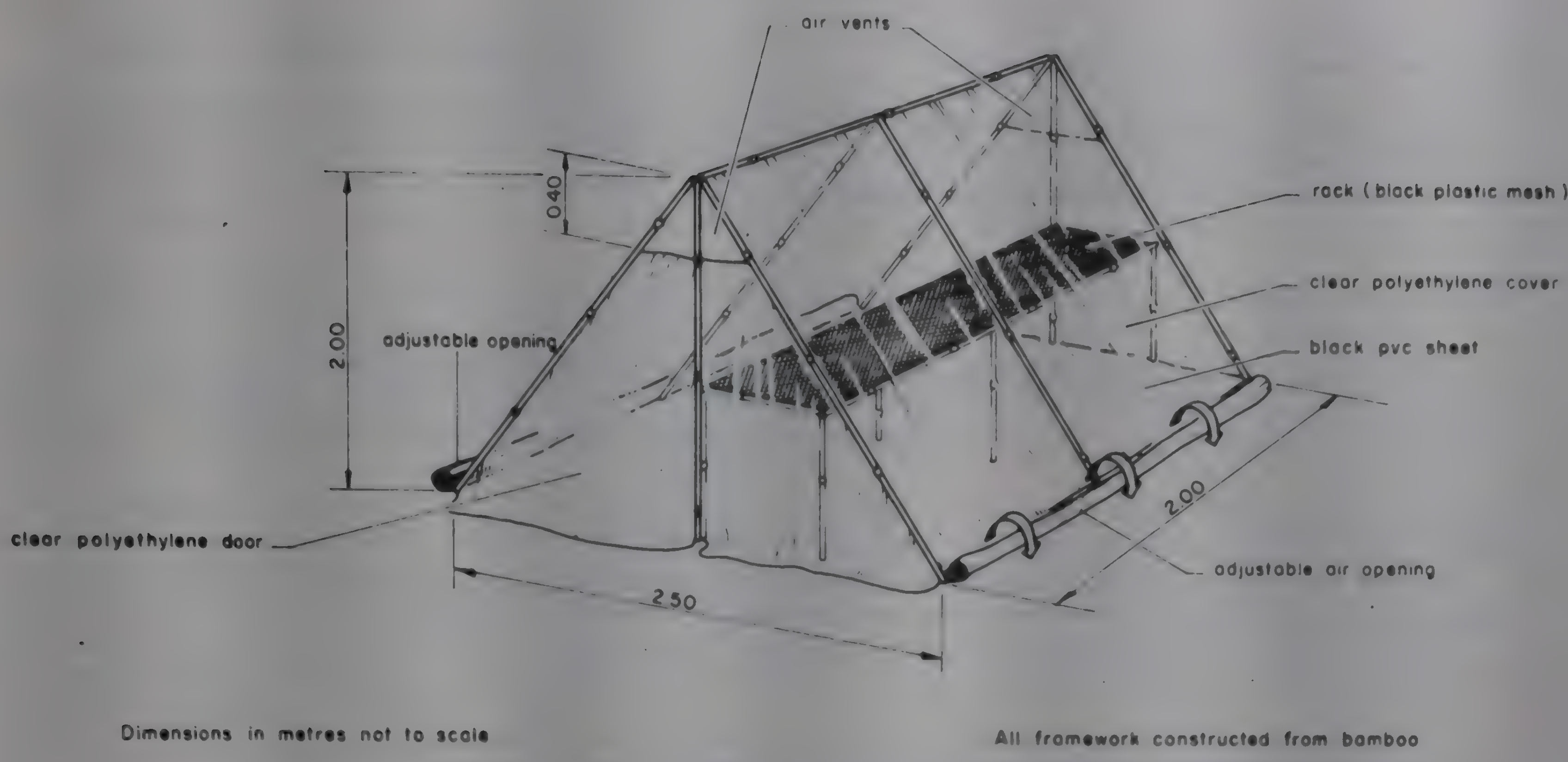

Fig. 1 SOLAR TENT DRYER

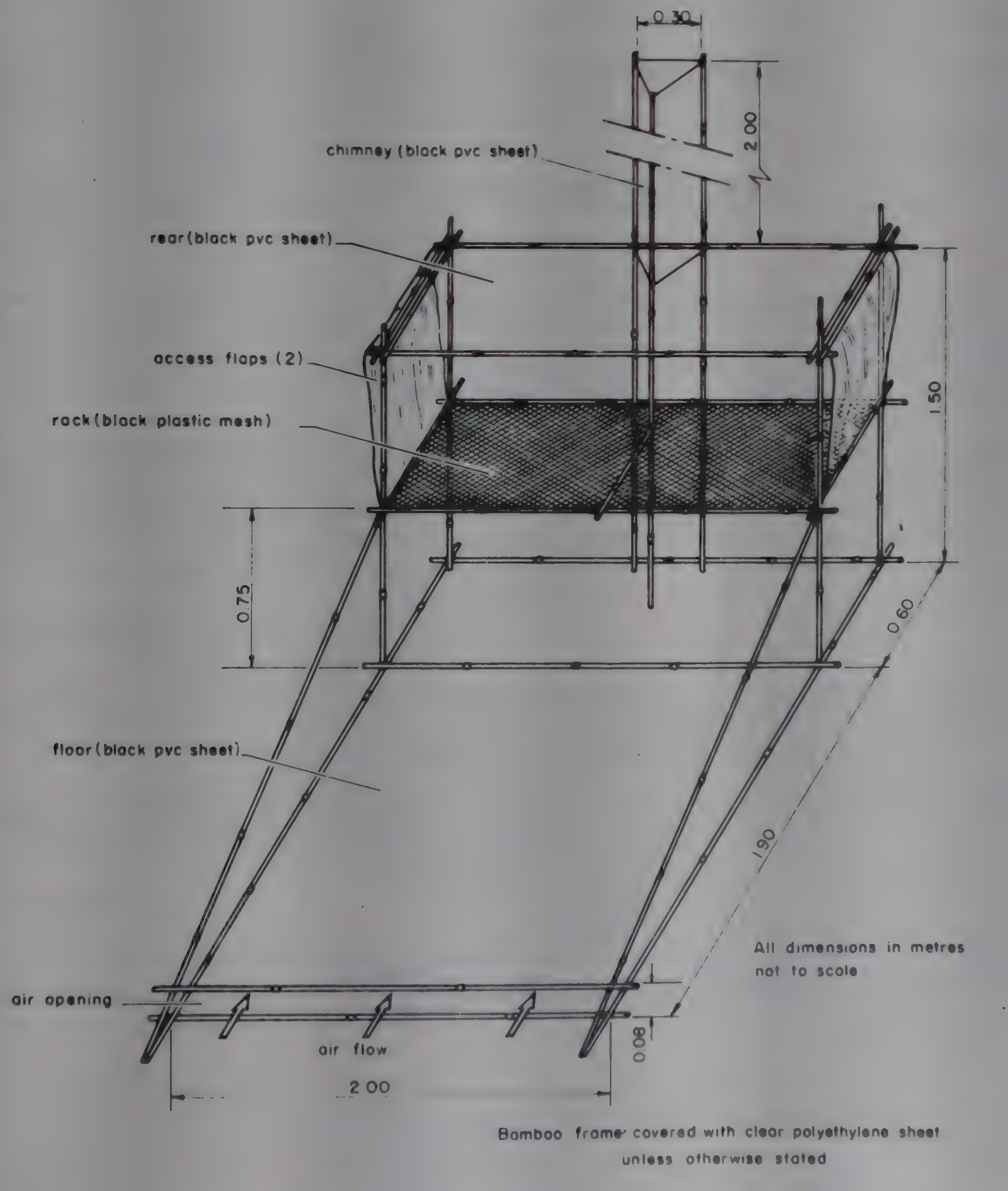

Fig. 2 SCD SOLAR DRYER

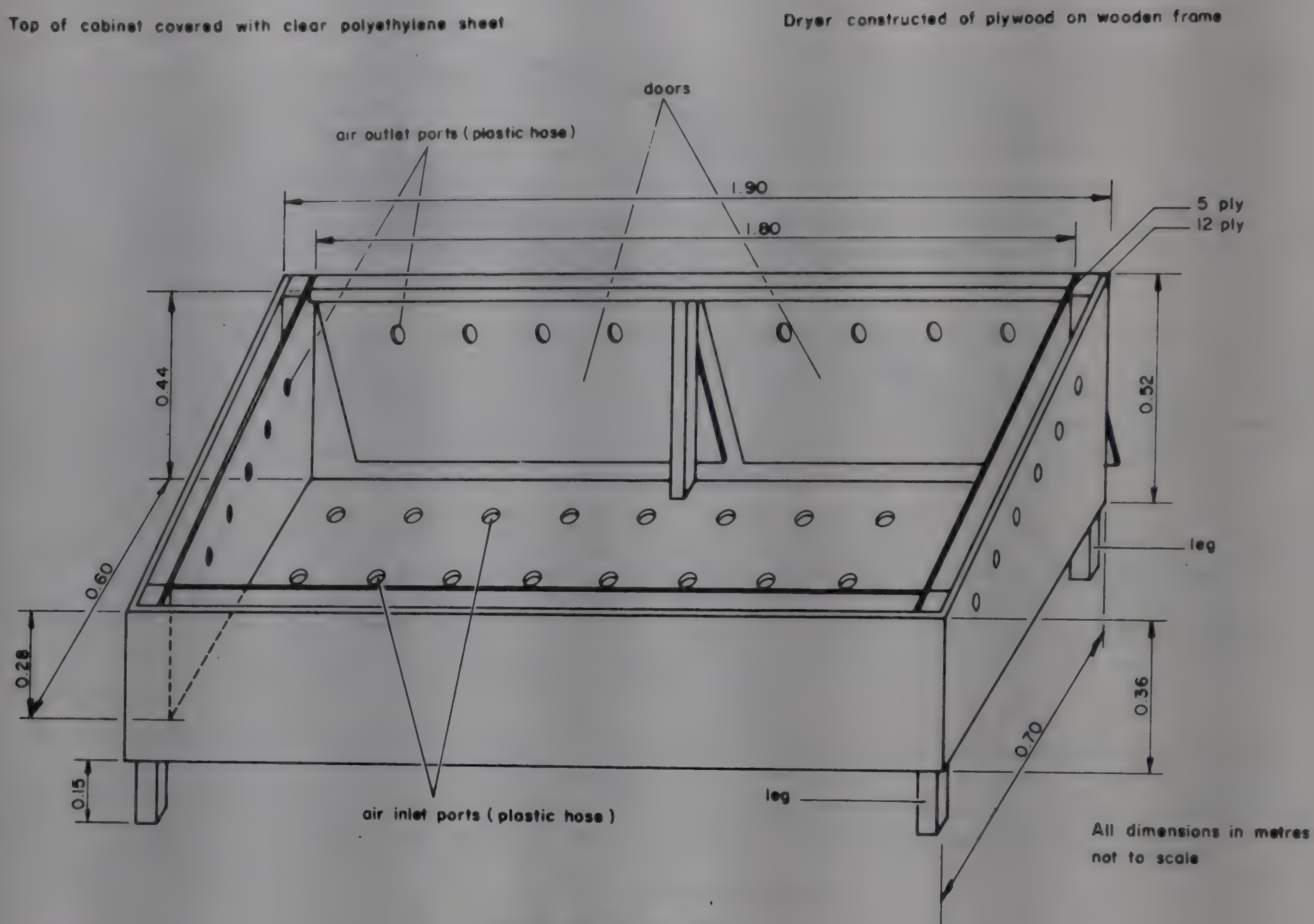

Fig. 3 SOLAR CABINET DRYER

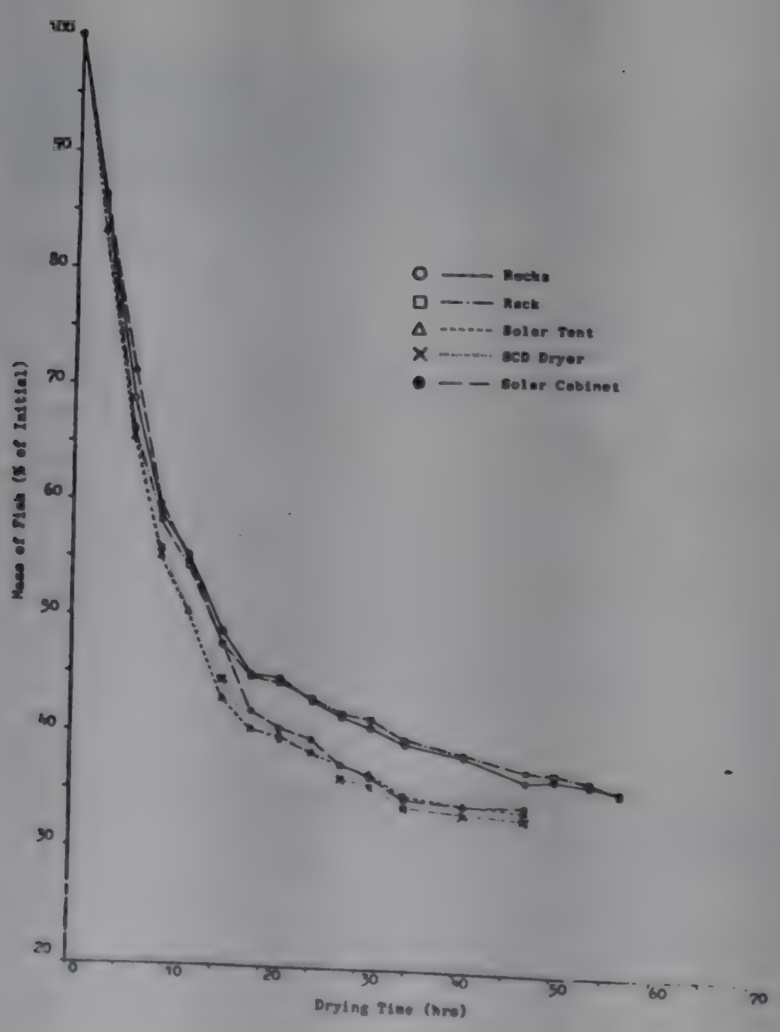

Fig. 4 DRYING CURVES FOR BRINED SPLIT PAMPANO

SCD solar dryer: This was developed by Exell (1980) and his co-workers (Exell, et. al., 1978 and 1979) in Thailand for drying paddy but recent work has been conducted with fish. It differs principally from the tent in that the solar collector and the drying chamber are distinctly separate as can be seen from the sketch of the dryer in Fig. 2.

The solar collector consists of a black plastic base and an inclined transparent plastic cover with a narrow opening across the full width of the front end. Air which is heated as it flows through the collector passes into the drying chamber before exhausting through the chimney. The black sides of the extended chimney absorb solar radiation which heats the air within, thus enhancing the natural convective flow of air through the dryer.

The dryer took 15 man-hours to build and the construction materials were identical to those used for the tent. The chimney and the base and back of the dryer were of black PVC, and the cover of the collector and the top and sides of the drying chamber were of clear polyethylene. Access to the drying rack was via plastic flaps on either side of the drying chamber, which were also used as a rudimentary means of controlling the internal temperature. It would be necessary to provide access flaps at the back of larger models for ease of loading as described by Exell (1980).

Solar cabinet dryer: This design was pioneered by Lawand (1966) and the Brace Research Institute (1973) and is probably the most widely used dryer developed to date. As can be seen from Fig. 3, it is essentially a rectangular cabinet with an inclined transparent cover. The optimum angle of incline of the cover is dependent upon the geographical latitude (Brace Research Institute,1973); for the Galapagos this angle was 15°.

Air enters through the air inlet ports in the base of the dryer, it is heated within the cabinet and rises to exhaust through outlet ports in the front and sides. Normally the front, sides and base are of double-wall construction and the cavity is filled with a good insulating material, e.g., sawdust. However, the cavity was left unfilled during this study to prevent excessive internal temperatures being attained since there is the risk of "cooking" and "case hardening", which is a hardening of the surface, caused by too rapid drying initially, that prevents adequate drying of the inner layers.

The cabinet was constructed from plywood on a frame of 50 mm x 50 mm wood in about 25 man-hours. Twelve-ply sheet was used for the external walls of the sides and front, and top of the base; 5-ply sheet was used for the internal walls of the sides and front, and the bottom of the base. Two doors of 5-ply sheet formed the back of the cabinet to allow loading of the trays and were used as a simple means of temperature control. All interior surfaces were painted with black matt paint to enhance the potential of the cabinet to absorb insolation. Plastic hose was used to form ducts through the two walls for the inlet and outlet ports. The dryer was mounted on legs to facilitate air entry through the base and to reduce the risk of entry of pests into the cabinet. The cover was a single sheet of clear polyethylene stapled to the frame.

Sun drying methods

Drying on rocks: Traditionally, fish are dried in the Galapagos by spreading them on prevalent black lava rocks. No steps are taken to protect the fish from birds, flies and other pests. A bed of black rocks was assembled and used in the local manner.

Rack drying: A raised, sloping drying rack was constructed from black plastic mesh supported 1 m above the ground by a bamboo frame.

Fish preparation

Drying trials were conducted using two species of locally available, freshly caught fish, lisa (*Xenomugil thoburni*) and pampano (*Trachinotus paitensis*), using six different treatments:

1. Dry salted split lisa: The fish were split along the backbone according to local custom, gutted, carefully washed and the flesh scored. The prepared fish were soaked in 10% brine for 30 minutes and were then packed in dry salt (1 salt:3 fish) and left overnight (21 hours) in a store.

2. Brined split pampano: The fish were split along the backbone, gutted, washed and all but the last third of the backbone removed. The flesh was scored and the fish totally immersed in saturated brine for 40 minutes.

3. Brined pampano fillets: Two single fillets were removed from each fish and washed, scored and placed in saturated brine for 40 minutes.

4. Brined split lisa: After being prepared as for Treatment 1, the fish were placed in saturated brine for one hour.

5. Unsalted split lisa: The fish were split as described previously but, after washing and scoring, were allowed to drain and were set to dry without salting.

6. Dry salted lisa fillets: Two single fillets were removed from each fish. The fillets were washed and scored prior to being soaked in 10% brine and then packed in dry salt overnight (approximately 12 hours).

Treatments 1,4,5 and 6 were repeated giving a total of ten separate drying trials. Locally produced solar salt was used for preparation of brines and for dry salting. After salting, the split fish or fillets were carefully washed to remove excess salt crystals from the surface and were allowed to drain. The batch of fish for each trial was divided into five equal lots and simultaneously set to dry in the three solar dryers, on the rack or on the lava rocks.

Operating procedure

Drying was carried out for $9^1/2$ hours each day. Adjustment to, and control of, the dryers was deliberately kept to a minimum to simulate their operation by a busy fisherman. Vents and openings were closed in the early morning and late afternoon to raise internal temperatures as quickly as possible and maintain them as long as possible; reasonable care was also taken during the hottest periods of the day to prevent the internal temperatures exceeding 55-60°C due to the risks of case hardening and cooking.

Approximately 8 kg of prepared fish could be accommodated in each of the solar dryers: this loading was maintained during all the experiments. Every three hours, the fish were weighed, and a note made of their condition, before being turned over to ensure even drying. At night, they were press piled and held in a store. Drying was terminated when successive weighings revealed little or no change in weight.

Solar radiation, wind speed, ambient temperature and humidity, and temperatures within the dryers were recorded at hourly intervals.

Final product analysis

Quadruplicate samples of all of the batches of the final dried salted products were analysed for: moisture, using an infra-red balance, salt (Pearson, 1970) and acid insoluble ash (AOAC, 1980, 1980a).

RESULTS AND DISCUSSION

Operation of dryers

Over the four-week experimental period, the average ambient temperature and relative humidity were 30°C and 74%. On a fine day with solar radiation of 17.6 MJ m^{-2} over a 9-hour period, the internal temperatures of the tent, cabinet and SCD dryers averaged 18, 19 and 19°C higher respectively than ambient temperature, whereas, on a cloudy day with solar radiation of only 8.9 MJ m^{-2}, their internal temperatures averaged 14, 14 and 11°C higher than ambient temperature. The vents and doors were fully opened around mid-day on

sunny days to prevent cooking or case hardening of the fish; if this had not been carried out, the difference in temperature elevation between fine and cloudy days would have been more marked.

On occasions, the temperature variation within the solar dryers was tested. A difference of $4^{o}C$ was the maximum temperature range in the vicinity of the drying rack (or trays).

Drying performance

Averaged data showing the relative performance of each dryer and sun drying method for certain changes in moisture content are presented in Table 1 while Fig. 4 gives typical drying curves for each dryer and sun drying method. Data for the unsalted split lisa have not been included since these trials were prematurely terminated because the drying rates were too slow to prevent putrefaction of the fish which occurred within a few hours of them being set to dry, regardless of the method employed.

Table 1

Relative performance of solar dryers and sun drying methods

Loss in moisture content		Relative drying times+				
From:	To:	Rocks	Rack	Solar tent	SCD dryer	Solar Cabinet
Initial	40%	100	92	73	73	85
40%	30%*	100	97	66	62	63
30%	20%**	100	110	58	56	48
Initial	20%**	100	105	65	60	63

\+ Expressed as the ratio of the averaged drying time for each method to the average drying time for the rocks.

* Drying times averaged for all 8 experiments completed.

** Drying times averaged for the 5 experiments in which 20% moisture was achieved by all the drying methods.

The solar dryers gave higher drying rates overall: on average, it took 3-4 days to dry a constant weight in the solar dryers while 4-6 days' sun drying were required. The difference in drying rates between solar and sun drying was relatively small in the initial stages (Fig. 4). However, as drying proceeded, moisture loss during sun drying became progressively slower than during solar drying. The tent and SCD dryers performed similarly throughout the drying process. Initial drying rates for the cabinet were intermediate between those for sun drying and the two other solar dryers. However, at low moisture contents, its drying rate was the highest of all the methods so that its overall drying time was similar to the tent and SCD dryers.

Drying rate is initially dependent upon the rate of air flow over the fish as moisture evaporates from the surface and is removed by the air. During the final stages of drying, as moisture migration to the surface becomes the controlling mechanism, the drying rate is then dependent upon air temperatures (Waterman, 1976). Both air flow and temperature exert an influence during the intermediate stages.

The similar initial drying rates for solar and sun drying can be explained by the natural breezes during sun drying being as effective as the air flow caused by natural convection within the solar dryers and the higher temperatures within the latter having little significant effect. As drying continued, the air flow exerted progressively less, and the higher temperatures within the solar dryers progressively more, influence resulting in the higher solar drying rates during the later stages.

The rate of air movement caused by natural convection is proportional to the height of the "air column" over which the temperature gradient exists. This height is considerably less in the cabinet dryer compared to the tent or SCD dryer; therefore, the air flow through the cabinet would be correspondingly less and would result in the slower initial drying rate. During the intermediate drying stage where both air movement and temperature exert an influence, the cabinet's drying rate is less than that of the other solar dryers due to its smaller air flow but greater than that of sun drying because of its higher internal temperature. Fish are placed much closer to the "hot" black surfaces in the cabinet than in the other dryers and the fish may, therefore, attain a higher surface temperature which would account for the higher drying rate in the final stages.

Since the solar dryers had a capacity of 8 kg of prepared fish per square metre and dry salted products required 3 days' drying during fine weather to attain 20% moisture accompanied by a 50% weight loss, the production rate was approximately 1.25 kg m^{-2} day $^{-1}$. Similar calculations for sun drying, which required 5 days, give a production rate of approximately 0.75 kg m^{-2} day $^{-1}$. These are only indicative figures since they will be affected by shape, size and species of the fish, the nature of the final product (e.g., moisture and salt contents, fillets, split, etc.) and weather conditions. The production rates of the tent and SCD dryers could be increased by the use of additional racks or by hanging the fish within the dryers.

There was a very slight difference in performance of the two sun drying methods. Table 1 shows that the fish on the rack initially dried faster but, at lower moisture contents, their drying rates were lower than those for fish dried on the rocks. The initial higher rate can be attributed to the better air circulation around the rack and, in the final stages, the faster drying of fish spread on the rocks may be due to the higher air temperatures as a result of their proximity to the black lava rocks.

Product quality

The fresh lisa and pampano were of excellent quality when purchased at the landing site. Ice was not available so they were held in seawater in a shaded position and were processed as soon as possible, thus ensuring only high quality fish were used for the drying experiments.

Visual examination of the final dried salted products indicated that the solar dried fish were of good quality and were marketable. The texture was hard and well dried and the products had a pleasant odour. The dry salted fish were of a light yellow colour whilst the brined products were dark orange showing signs of rancidity. Sun dried products were of poorer quality, particularly the fish dried on the lava rocks: there were sand and dirt adhering to the flesh and the fish had suffered from attack by blowflies, birds and other animals. However, the sun dried products were of better quality than locally produced dried salted fish, which were generally well salted but insufficiently dried and had a very strong unpleasant odour. None of the experimental products showed any evidence of mould attack, "pinking" caused by salt-tolerant bacteria, beetle infestation or case hardening.

Lower final moisture contents were achieved in the solar dryers: the average equilibrium moisture content of solar dried fish was approximately 13%, expressed on a wet weight basis, while that of sun dried fish was approximately 21%. At these moisture contents, dry salted products had an average salt content of 25% and the brined products of 13%.

The stability of salted and dried food products (Scott, 1957) depends on their water activity (a_w) which is a measure of the water available, for example, to support the growth of micro-organisms, such as bacteria and moulds (Waterman, 1976). Reducing the water activity, e.g., by salting and/or drying, will cause a reduction in the growth of bacteria and moulds as well as reducing the range of micro-organisms which can grow.

Using the results of the moisture and salt determinations and the method of calculating a_w and estimating mould-free shelf life outlined by Poulter, et. al.,(1981), it can be shown that all the solar dried products had a_w below 0.65 and a predicted mould-free shelf life of over 450 days. The sun dried products had a_w of 0.65 and above and would have a predicted mould-free shelf life between 100 and 450 days. However, since lisa are a species of medium fat content and pampano a species of high fat content (Sidwell, et.al., 1974), the actual shelf life of the dried fish may be shorter due to rancidity.

During this study the fish were dried until there was no further appreciable weight loss but, in commercial practice, this might not be necessary. However, if a shelf life of more than three months is required, using the method of Poulter, et. al., (1981), it is possible to predict that the moisture content would need to be reduced to 15-20%, regardless of the salt concentration, which was not always possible during sun drying. Therefore, when using the solar dryers, it is not only possible to achieve higher drying rates but also lower moisture contents and, in turn, a more stable product.

The actual rate of reducing a_w, and therefore the rate of drying, will affect product quality since spoilage will not be retarded until a_w is sufficiently lowered. Thus, products dried in the cabinet would probably have deteriorated more than products dried in the other two solar dryers but less than the sun dried products. This would not necessarily be apparent at the completion of drying but would become so during storage.

Acid insoluble ash is a useful index of mineral matter, such as dirt or sand, in foodstuffs (Pomeranz and Meloan, 1978). On average, the products which were dried in the solar dryers and on the rack had 1.0% or less acid insoluble ash, calculated on a dry weight basis, while those dried on the rocks had 1.3%. This indicates that the fish dried on the rocks were generally more contaminated by dirt, etc., than any of the other fish and it was possible to obtain as clean a product by drying on the rack as it was by solar drying.

Blowflies were a major problem during drying. The fish dried on the rocks were heavily infested with blowfly eggs and larvae; infestation also occurred in the rack dried fish but to a lesser extent. The solar dried fish showed little evidence of blowfly attack since the flies were killed by the high temperatures prevailing within the solar dryers. The primary effect of salt in dried fish is bactericidal but it also retards insect infestation (Proctor, 1977). This could be seen during the study since blowflies were less attracted to the dry salted products compared to the brined products, and unsalted fish were usually completely covered by flies during sun drying. It was necessary to wash the rocks to remove the large piles of eggs laid by the flies when brined or unsalted fish were being dried.

Fish were carried into the tent during loading and spread on the drying rack. However, with the cabinet and SCD dryers, loading was accomplished from outside and a large number of flies were attracted by the fish and, subsequently, ventured inside the dryers. This was particularly noticeable with the cabinet where escape was more difficult for the flies because the doors were closed immediately following loading. On sunny days, most of the flies in the cabinet were killed within three hours of loading the dryer each morning, by which time the internal temperature had reached 55°C or above. When killed by the high temperature, the flies fell onto the fish and, due to contamination of the fish by the bacteria carried by the flies, this could result in faster spoilage of the product before drying is completed (particularly at the higher temperatures within the dryer) and could also be a potential health hazard. As a result, it is not possible to recommend the use of the cabinet dryer for fish unless further steps are taken to prevent entry of flies. Draping mosquito netting over the doors to reduce the entry of flies may lessen the problem but would increase costs and involve a more complex operating procedure.

Most of the dead flies in the tent and SCD dryers were found on the floor. The flies are easily removed by sweeping the tent floor but some means of entry into the SCD dryer is necessary for cleaning purposes. This could be accomplished simply by positioning a flap below the drying rack.

Material and operating costs

Material costs, which are specific to the Galapagos, are given in Table 2. There was little difference in material costs of the tent and SCD dryers but the cabinet was approximately 40% more expensive. All three dryers were more expensive than the rack; no material costs were incurred with the rocks. Obviously substitution of cheaper local materials, where possible, would reduce these costs.

Table 2

Material costs of the solar dryers and sun drying methods

Drying method	Cost US$ (*)
Rocks	-
Rack	22
Solar tent	70
SCD dryer	75
Solar cabinet	104

(*) May 1981.

The major component of operating costs, excluding labour, would probably be maintenance, particularly replacement of the plastic sheet. This accounted for 43% and 39% of the material costs for the tent and SCD dryers respectively but only 2% for the cabinet, which would therefore be expected to have lower operating costs.

CONCLUSIONS

There was very little difference in overall drying rates obtained with the three solar dryers and similarly very little difference between those of the sun drying methods. However, fish dried in the solar dryers took an average of about 60-65% of the time required for sun drying to achieve a final moisture content of 20% under fine weather conditions, some three days in the solar dryers compared with five days when sun drying. Since initial sun and solar drying rates were similar and a reasonably clean product was obtained by rack drying, it may be worthwhile considering sun drying on a rack initially and then completing the process in a solar dryer, thus increasing the throughput of the solar dryers. With a load of 8 kg prepared fish, the production rate for dried salted fish was approximately 1.25 kg m^{-2} day^{-1} for solar drying and 0.75 kg m^{-2} day^{-1} for sun drying.

It was possible to achieve a greater reduction in moisture content by solar drying (to 13% on average) than by sun drying (21% on average). Since storage life is dependent in part upon moisture content, solar drying could give a product with a much longer shelf life if required although yield would be slightly less.

Fish dried in the three solar dryers were of very high quality. However a possible health hazard might exist with fish dried in the cabinet due to the large numbers of flies which were attracted and trapped inside the dryer. Rack dried fish were of higher quality than those dried on the rocks, which in turn were better than those produced by the local fishermen.

Material costs for the tent and SCD dryers were similar and much cheaper than that of the cabinet dryer, using prices currently applicable in the Galapagos. All three were more expensive than the rack while there were no material costs for the lava rocks. The construction time for the tent is considerably shorter, and the principles of construction and operation would be easier to communicate to an artisanal fisherman, than those of the two other dryers.

In conclusion, the tent appears to be the most suitable dryer for use by an individual fishermen. In the Galapagos Islands, the capacity of these solar dryers would be sufficient to dry part of an individual fisherman's daily catch but a greater capacity would be required for the larger boats, several of which often return to port together after 15-20 days' fishing.

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SOLAR DRYERS FOR FISH

by

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ABSTRACT

Traditional methods of open air drying of fish need modification and improvement, due to consumer demand for higher quality products, but with a minimum increase of processing cost. Solar dryers have been proposed as a suitable alternative to an open air drying. This article reviews the presently available methods and additional use of biomass as source of energy.

Drying of fish and fish products is an important method of fish preservation for most traditional fishing communities in tropical countries. In Malaysia, it was estimated that more than 90% of the total processed fish products involved a degree of drying. Currently, fish drying is conducted by open air systems during the non-monsoon period. However, this process offers several disadvantages:

(1) The products are exposed to various contaminating agents such as dust, dirt and sand. This problem is particularly serious for the drying of small shrimps.

(2) Products are also exposed to insect infestation, especially flies. Products are normally heavily salted in order to reduce infestation. Lightly salted products which are more in demand cannot be produced in significant quantities because of this problem. Large size fish are also prone to flies laying eggs inside the body and in the cavities.

(3) Drying is frequently interrupted by rain, clouds and darkness and in any case is restricted to 5-6 hours per day. The interruption of the drying process drastically reduces the quality of certain dried fish such as Stolephorous species (ikan bilis).

(4) Fish dried in the open air has to be covered or stored at the end of each day and uncovered for the next drying day; the same procedure must be carried out whenever there is a possibility of rain. This is a very laborious process, diverting labour from doing other work.

For many years dried fish was considered a poor man's food in Malaysia. Most of the fish had an unpleasant odour, a yellow colour and was frequently infested with maggots. Today, dried fish has become accepted in most people's diets. It is no longer considered a poor man's dish and some dried fish are served in many prestigious restaurants and hotels. Deep fat fried 'ikan bilis' is served as a snack in bars and hotels. Although dried fish is now accepted by the middle class society in Malaysia, the low quality dried fish described above can still be found in many places in Malaysia, as well as other developing countries in the region. The technology of dried fish handling, storage and processing has changed very little over the years.

With the changing attitude of consumers towards food hygiene and cleanliness, it is expected that their preferences for dried fish will also change. A recent consumer survey indicated that the following subjective characteristics are desirable (Latiff *et al.*, 1982):

(i) Not too salty

(ii) Pale colour and not yellow

(iii) No rancid smell

(iv) No maggots

(v) Not too wet or too dry

These changes in the attitude of the Malaysian consumers have led the processors to improve their processing, drying and handling procedures. It is expected, therefore, that the drying of fish will be conducted under more controlled conditions and packed in more hygienic and appealing form.

Fish Drying and Dryers

Under normal tropical sunshine conditions, the drying of salted fish is still most economically done in the open air. The process is inexpensive, it requires very little capital investment, no maintainance and no skill to produce a high protein product. Under the traditional fishing practices it served its purpose very well, and absorbed seasonal gluts. No fish was caught during the wet season and therefore no drying was needed. With improvements in fishing technology and regular landings for much of the year, fish and fish products need to be dried throughout the year. Therefore, open air drying is no longer the ideal method for fish drying. Alternative drying methods must therefore be provided.

Mechanical, fuel-heated dryers could easily be used to take the place of the open air drying process. However, the cost of the equipment and its operation is prohibitive to most dried fish processors in the region. Solar dryers are considered by many researchers to be a possible alternative. Three types of dryers are discussed in this paper:

(a) Solar tent dryers

(b) Shoe box or cabinet dryers

(c) Collective-convective dryers

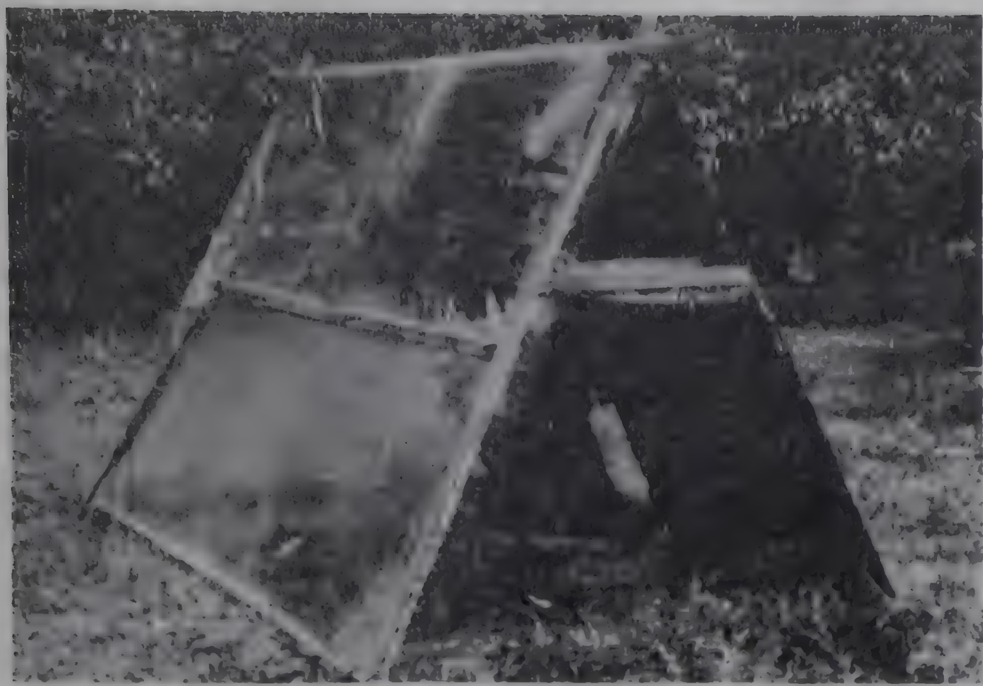
Solar Tent Dryer

The polythene tent dryer was first introduced by Doe *et al.* (1977) in Bangladesh. They reported that these dryers were suitable for the disinfestation of blow flies as well as for drying fish. Similar experiments were conducted in 1978 in the Philippines (Pablo, pers. comm.), Papua New Guinea, Malaysia, Senegal, Sri Lanka, Guyana and India (Philippines, Ministry of Energy/Unesco/ASEAN/Regional Network for Solar Energy, 1978). This form of dryer is a simple 'A' frame construction erected over a drying bed.

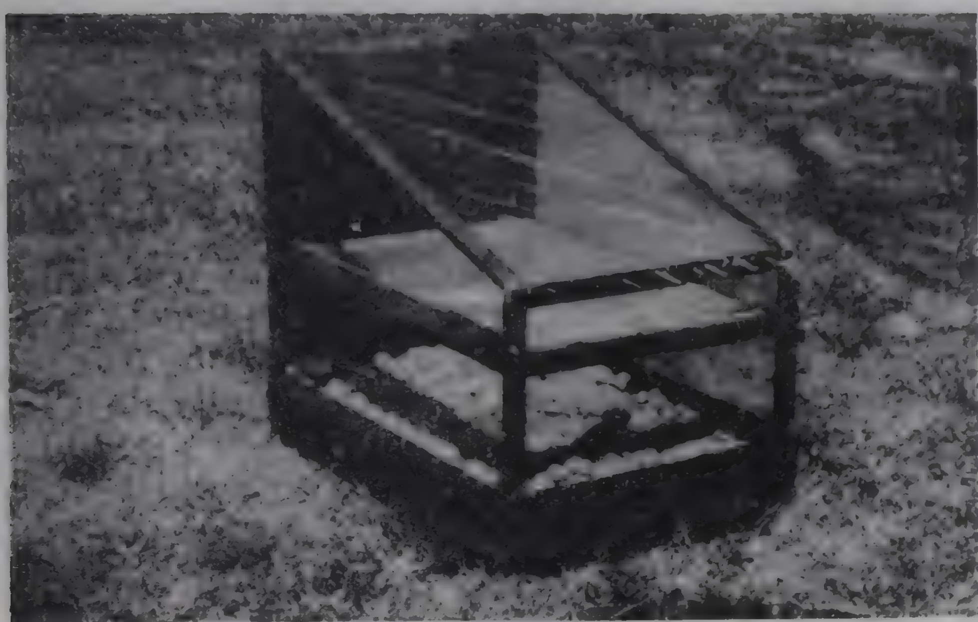
This is the simplest and the least expensive dryer to build. It could be constructed whenever and wherever required. Despite the favourable conclusions by several scientists regarding the efficiency of tent dryers in increasing the temperature, the author's experience has been that the drying rate was actually lower than that of the open air drying despite the high temperature. Doe *et al.* (1977) reported that a temperature of more than 50°C was achieved inside the dryer compared to the outside temperature of 33°C, yet the drying rate was higher for the samples dried in the open air. This was probably due to the limited movement of the moist air surrounding the samples that were dried inside the dryer while the free movement of air allowed rapid evaporation of moisture from the samples dried in the open air. However, this type of dryer is suitable for use by those who dry fish in small quantities.

Cabinet Dryer

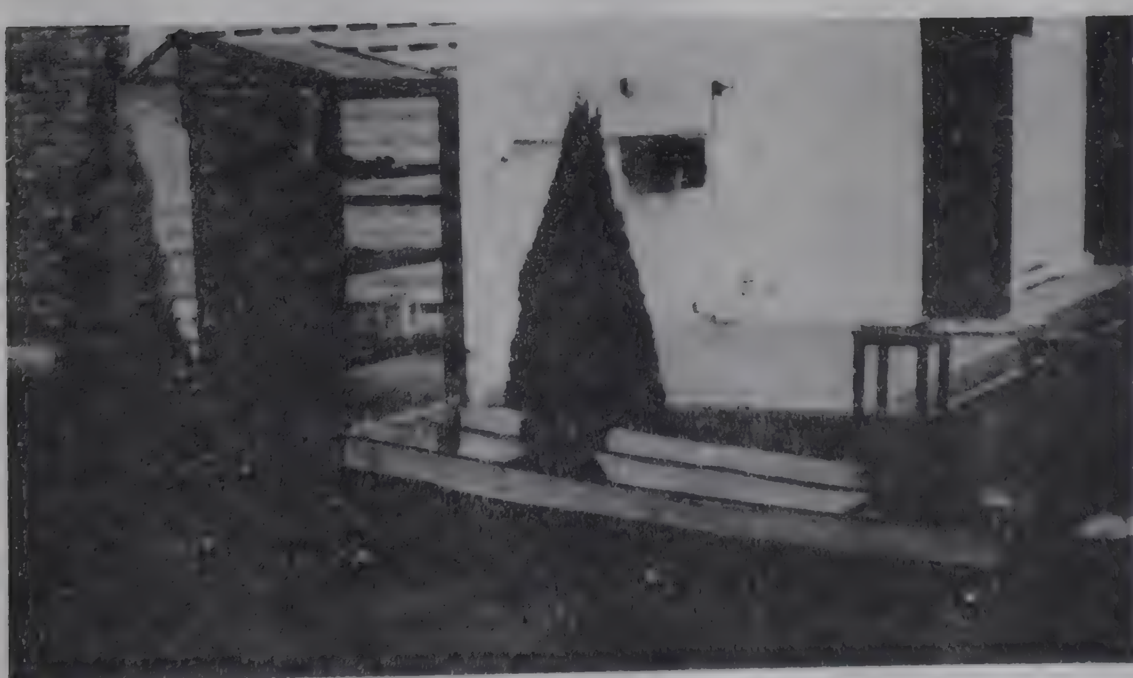
The second type of dryer is the shoe box dryer which was tested in the Philippines and Papua New Guinea. The frame of this dryer and its earlier model is made of wood and covered by the plastic layer. This type of dryer was reported to be more efficient than the tent dryer (Philippines, Ministry of Energy/Unesco/ASEAN/Regional Network for Solar Energy, 1978).



Solar tent dryer



Cabinet dryer



Collective-Convective dryer

Collective-Convective Dryer

Most types of dryers are of the collective-convective type. An inexpensive simple model was constructed and tested by the author at the University Pertanian Malaysia.

The drying chamber was constructed from a wooden frame with a layer of transparent plastic forming the four walls and the top. The back of the chamber was painted black to improve heat absorption. The inside of the chamber was compartmentalized by three wire mesh partitions which were used as drying racks. An absorber was made of a black painted galvanized zinc, sandwiched between an insulator at the bottom and transparent plastic on top. The insulator was made from padi straw, supported by a wooden frame with a plywood base. Both the absorber and the drying chamber were constructed on wheels for easy movement.

Drying experiments were conducted with medium sized carangid fish (*Megalaspis coryla*) (average length 25 cm). A control experiment was carried out by drying the fish in the open air during the day (09.00;16.30 h) and keeping it inside the laboratory in the evening. A comparison of moisture loss by this method versus drying by normal methods indicated a more efficient drying process for samples dried inside the dryer. When large size samples (average length 60 cm or more) were used in the dryer, the samples exhibited case hardening and had a low drying rate.

It was thus found that the collective-convective solar dryer was more efficient than the open air drying system. It was also effective in preventing contamination and infestation of the product.

Although all the above dryers were effective in reducing infestation and contamination, the tent dryers have a lower drying rate than the open air drying method. The cabinet and collective-convective dryers are only slightly more efficient than an open air drying under bright sunny conditions. Solar dryers are, however, effective when there was an intermittent rain and sunshine.

The major disadvantage of a low cost solar dryer is that its drying rate and capacitv is only slightly improved under normal sunny conditions. When there is rain, or during darkness, there is no drying. Thus, there is no distinct advantage for a processor to invest in a solar dryer. It is expected that the need for a large capacity dryer could be better met by the use of a biomass-solar dryer which is currently being tested by the author.

Conclusion

The market for dried fish is still good in East Asia despite a continuously changing life style. With improved living standards, the demand for better quality dried fish will continue to increase. The lack of drying space, shortage of man-power, pollution and the need for a better quality product will be some of the forces favouring the utilization of a cost effective drying method for fish.

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DEHYDRATION PROCEDURES FOR MACKEREL
(Pneumatophorus japonicus)

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Philippines

ABSTRACT

Dehydration, acceptability and storage stability of mackerel *(Pneumatophorus japonicus)* have been studied. The traditional method of splitting the fish before drying has been modified by beheading and splitting it on its ventral side. Head-on and headless mackerel were subjected to three methods of drying, namely: direct sun drying, solar drying using a polyethylene vinyl (PEV) solar dryer and a combination of the two methods. Acceptability of head-on and headless dried mackerel showed similar results. Sun-dried headless mackerel were preferred although the PEV solar dried and those dried using the combination of the two methods were also accepted. PEV solar dried samples contained the lowest microbial load and moisture content and lasted for twelve weeks at refrigerated temperature (18°C). The combination of sun drying and PEV solar drying took the shortest drying time.

INTRODUCTION

Mackerel is one of the most common food fishes in the Philippines and in other countries. It is a potential raw material for canning, drying, smoking and other fish processing industries considering its abundance and nutritive value.

In the Philippines, dried fish is acceptable to all income groups and is considered as a staple food item which provides a good source of protein. A study by Aviguetero *et al.*, showed that the average *per caput* consumption of dried fish in the Philippines is 4.45 kg annually and of the average annual production of dried fish by all firms in Metro Manila, 99% is sold for human consumption while 1% goes to animal feeds. Dried fish is the Philippines' biggest export of processed fishery products (Fisheries Statistics, 1981).

The fish drying industry exists in almost all fishing villages of the country, mostly on small and medium scale using traditional methods of sun drying.

Several studies on the standardization of drying procesures for fish have been conducted, to improve quality and general acceptability as well as to minimize wastage and losses in production. The technology of artificial dehydration and low cost fish dryers is already available but due to high investment cost, the average small-scale fish processors cannot profit from it.

Palomares *et al.* (1981) conducted a study on the dehydration characteristics and packaging requirements of fish and other marine products using a multi-heat source dryer. Guevara *et al.* (1978), conducted a study on the standardization of drying, fermentation, and smoking of milkfish. However, some of the local fish processors are slow if not reluctant to adopt new technologies. They still cling to the old methods thus, the fish drying industry which is mainly dependent on weather conditions, operates seasonally and the same problems that have existed for years are still prevalent. Packaging has taken a great leap but the attainment of uniformity in the quality of the finished products remains difficult.

In the dried fish processing line, little or no attention is given to the inedible parts of the fish such as the heads, entrails, bones, etc., which if properly utilized can be manufactured into other useful fishery by-products.

Economical and efficient utilization of fish can be achieved only if all the parts are utilized and no wastage is allowed in the industry (Canonizado, 1977). The inedible portion of fish, approximately 40-50% of the weight of the raw material is a potential source of fishery by-products. Without considerable attention this will lead to serious forms of wastage and losses in production. Proper utilization of fishery resources as valuable products will consequently bring about better utilization and the production of low-cost sources of protein and essential vitamins and minerals.

This study was conducted at the Fisheries Utilization Division of the Bureau of Fisheries and Aquatic Resources in order to: (i) compare the three methods of drying, namely: sun drying, solar drying using polyethylene vinyl (PEV) solar dryer and the combination of the two methods, (ii) to modify and improve the traditional procedure of preparing the fish by beheading and splitting it on its ventral side and (iii) to determine acceptability and shelf-life during storage at room temperature and refrigerated temperature.

EXPERIMENTAL DESIGN

Fresh mackerel (*Pneumatophorus japonicus*) was purchased from Divisoria Market, Manila. They were divided into two lots, one was dressed as butterfly fillets and the other was beheaded and split on the ventral side. They were washed thoroughly and soaked in 1:3 brine (25° Salometer) for 1.5 h. Each lot was further divided into three for sun drying, PEV solar drying and for drying using the combined method. Figure 1 shows the diagram of the PEV solar dryer used in the study. The temperature was recorded from each method of drying hourly until the products became dried to a moisture content ranging from 26 to 40%.

Dried samples were packed in 0.002 polyethylene bags and stored at room temperature (32°C) and at refrigerated temperature (18°C). The initial sensory, chemical and microbiological analysis were conducted on the products. Sensory evaluation was conducted on the products by a panel of trained judges and the scoring was done using the 9-point hedonic scale for sensory evaluation of fish and fishery products developed by Larmond (1975). Samples were observed and analysed periodically.

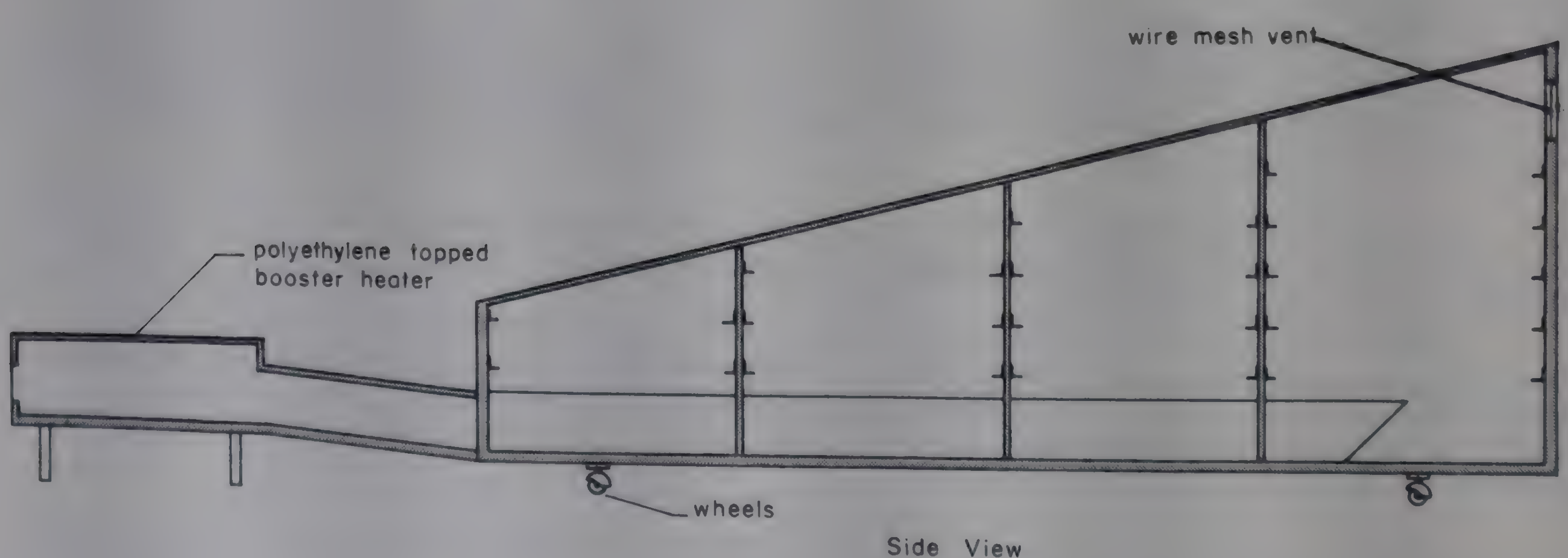

Figure 1 Solar dryer (polyethylene covered wooden frame)

RESULTS AND DISCUSSION

Preparation of the Fish for Drying

The traditional method of preparing medium-sized fish for drying is done by splitting the fish on its dorsal side and taking out the intestines. This procedure was modified in the study by beheading the fish first and splitting it on its ventral side. The fish were soaked in 1:3 brine for 1.5 h before drying using sun drying (X), PEV solar drying (Y), and the combined method (X and Y).

The procedures used are illustrated in a flowsheet on Figures 2, 3 and 4.

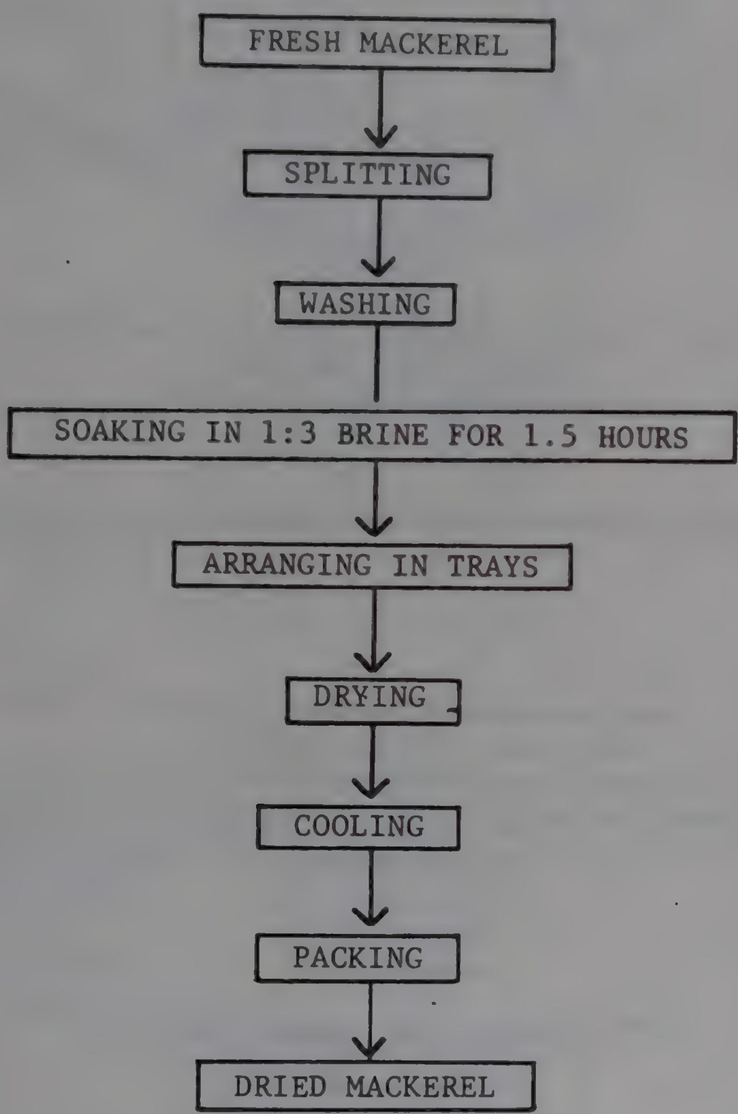

Figure 2 General Procedure for Drying Mackerel

General Acceptability

The products were cooked and served to a panel of trained judges for sensory evaluation. The 9-point hedonic scale for sensory evaluation of fish and fishery products was used. The products were rated as to colour, odour, taste and texture.

Table 1 shows the general acceptability of dried mackerel using the three methods of drying.

Results of the analysis of variance tests showed that there was no significant difference of the general acceptability between the head-on and the headless mackerel. Organoleptic tests showed a marked preference for sun-dried products due to texture characteristics. Nevertheless, PEV solar dried and those dried using the combined method showed similar results and were both acceptable.

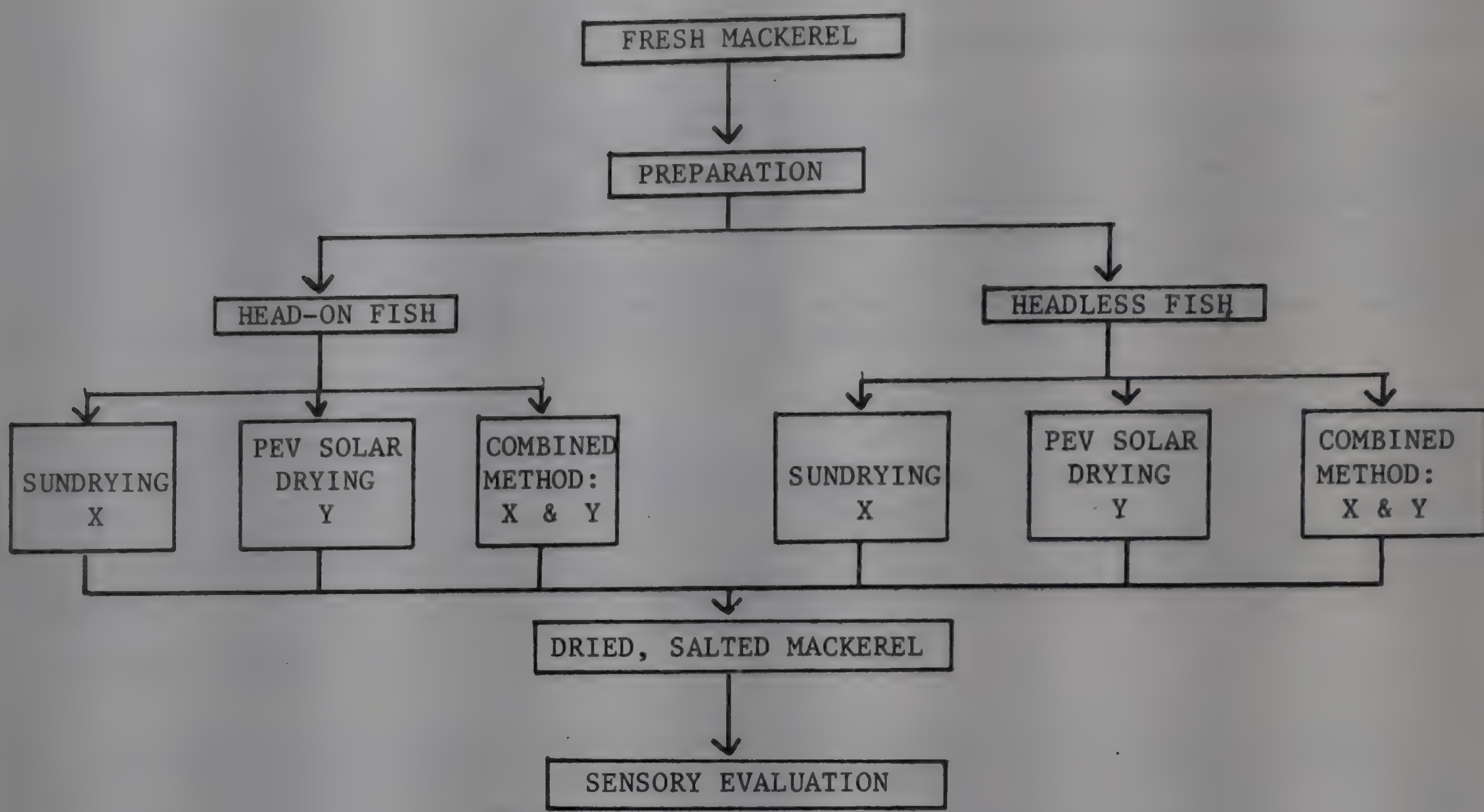

Figure 3 Flowsheet on drying of head-on and headless mackerel using three methods of drying

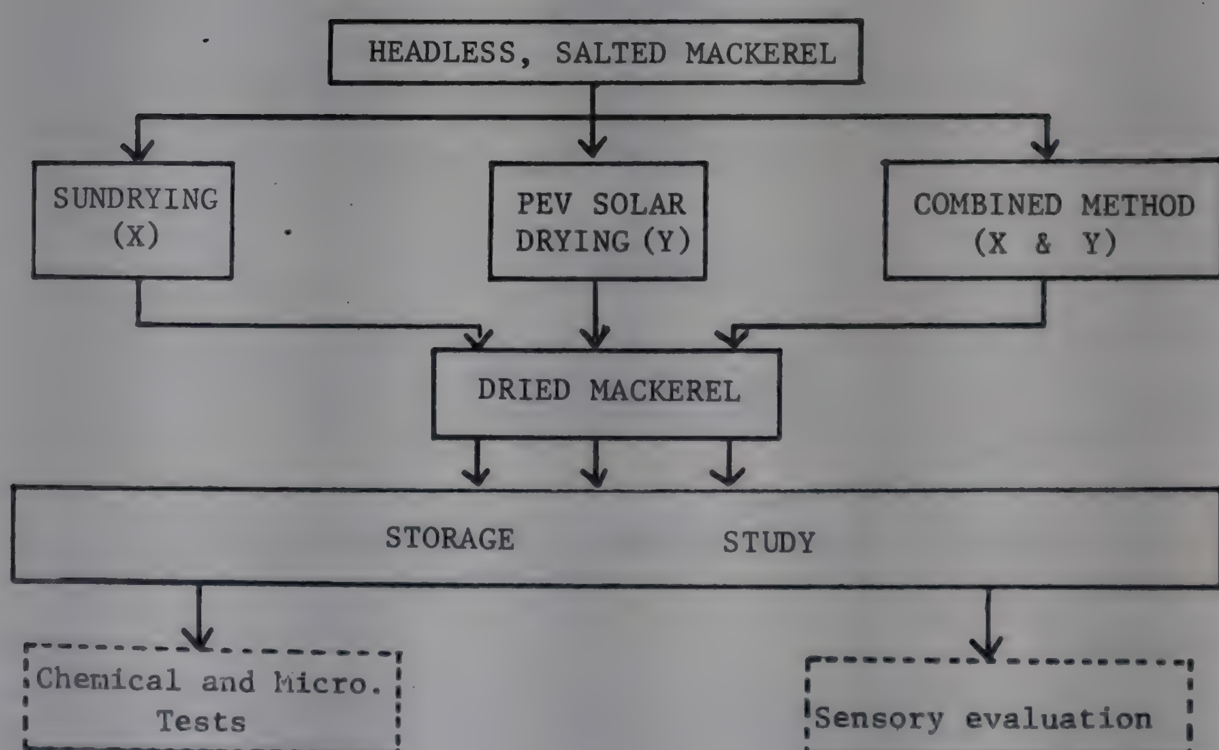

Figure 4 Flowsheet on the storage study of dried, headless mackerel using three drying methods

Table 1

General acceptability of dried mackerel

Products	Sun drying (X)	PEV solar drying (Y)	Combined method (X and Y)
Mackerel:			
(a) Head-on	8.7	8.5	8.5
(b) Headless	8.5	8.2	8.3

Determination of Moisture Content

The moisture content of the products was determined by using the Ohaus moisture meter. Table 2 shows the moisture content of mackerel dried using sun drying, PEV solar drying and the combined method.

Table 2

Final moisture content of dried mackerel

Products	Sun drying (%)	PEV solar drying (%)	Combined method (%)
Mackerel:			
(a) Head-on	39.63	36.83	38.86
(b) Headless	39.50	36.49	38.51

Results showed that there is no marked difference in the moisture content of headless and head-on mackerel but a remarkably lower moisture content is noted in PEV solar dried samples. The other two methods showed similar results.

Table 3

Average drying times of mackerel

Products	Sun drying (36-49°C)	PEV solar drying (55-60°C)	Combined method (36-49°C and 55-60°C)
Mackerel:			
(a) Head-on	11-12 h	9-10 h	8-9 h
(b) Headless	11-12 h	9-10 h	8-9 h

Determination of Drying Time

The drying time was determined by recording the number of hours in each trial and the average number of hours from each drying method used. Table 3 shows the average drying time for headless and head-on mackerel dried using the three methods of drying.

Due to a higher temperature in the PEV solay dryer, the drying time is shorter as compared to sun drying. However, drying using the combination of sun drying and PEV solar drying takes a much shorter drying time as compared to the other two methods. Here, the

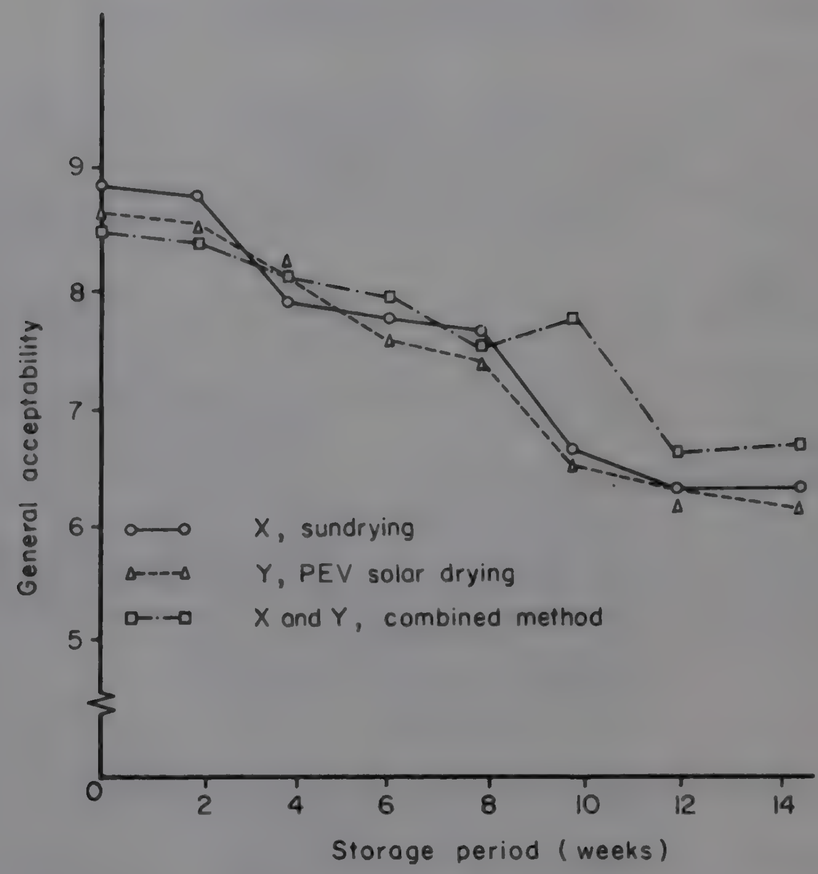

Figure 5 General acceptability of dried, headless mackerel under storage at 18°C

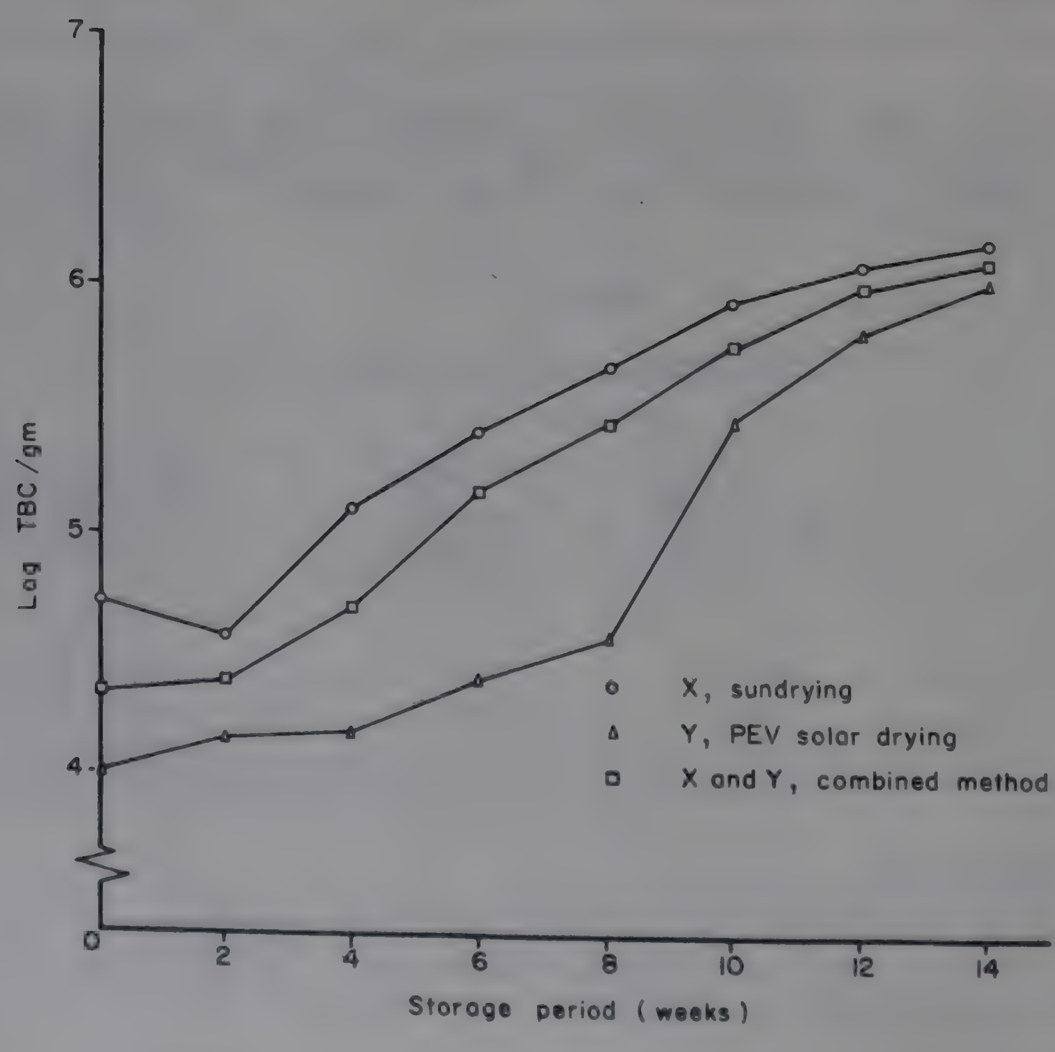

Figure 6 Log total bacterial count (TBC) of dried, headless mackerel stored at refrigerated temperature (18°C)

fish were subjected to sun drying during the first 3-4 hours then transferred to the PEV solar dryer during the rest of the drying period.

Storage Studies

Dried headless mackerel samples were stored at room and refrigerated temperature. Results of their general acceptability during storage are shown on Figure 5. Figure 6, on the other hand, shows the Total Bacterial Count (TBC) of dried headless mackerel stored at refrigerate temperature. It shows that sun-dried products exhibited the highest initial microbial load as compared to the two other methods of drying used. This is due to the fact that the products were exposed to open air with free access to all sources of contamination such as dust, flies, dirt, wind-blown debris, etc. The PEV solar dried products exhibited the least microbial load because the product was protected from contamination by its plastic covering. Growth of microorganisms in sun-dried products was rapid during storage while it was gradual and minimal in the PEV solar dried ones.

Samples dried using the combination of sun drying and PEV solar drying exhibited a gradual increase in microbial load during the eight weeks of storage. Microbial growth rose more rapidly on the 10th and 12th week of storage.

Products stored at room temperature (32°C) exhibited mold growth on the 3rd and 4th day of storage. The growth of *Aspergillus* sp., *Penicillium* sp. and *Mucor* sp. was noted on the products.

SUMMARY AND CONCLUSIONS

The study on "Dehydration Procedures for Mackerel (*Pneumatophorus japonicus*)" was conducted to determine the acceptability of dried headless mackerel using three drying methods, namely: sun drying, PEV solar drying and the combined method of sun drying and PEV solar drying, and to determine the shelf-life of the dried headless mackerel at room and refrigerated temperature using chemical, microbiological and sensory methods of analysis.

Three methods of drying were employed in the study, namely: sun drying, PEV (Polyethylene vinyl) solar drying and the combined method of sun drying and PEV solar drying. The ordinary way of splitting the fish on the dorsal side has been modified by beheading the fish first and then splitting it on its ventral side.

Dried headless mackerel samples were stored at room temperature (32°C) and refrigerated temperature (18°C) for storage studies. Sensory, chemical and microbiological analysis were done periodically to determine its general acceptability and shelf-life during storage. Results of the study showed that dried headless mackerel split on the ventral side is as acceptable as the head-on samples.

PEV solar drying is effective as it takes a shorter drying time, reaches a maximum temperature of 55-60°C easily and yields products with low microbial load as compared to sun drying. The PEV solar dryer therefore is recommended for drying fish and other marine products. Using the combined method of sun drying and PEV solar drying hastens the drying process. Dried fish stored at refrigerated temperature (18°C) were still acceptable until the 12th week of storage. Those stored at room temperature (32°C) lasted for 4 weeks. Hence, if a longer shelf-life of dried products is desired, refrigeration is necessary.

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STORAGE OF SOLAR-TENT DRIED POMFRET (*STOMATEUS SPP.*)

by

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ABSTRACT

Pomfret pre-treated with antifungal agents and antioxidants was dried in a polyethylene solar tent and stored at different temperatures under two different packaging methods.

Antifungal agents and antioxidants (potassium sorbate, malic acid, alum, bleaching powder, hypochlorite, BHA, BHT), were used individually and in combination for pre-treatment of fish along with brine before drying. Mixtures of potassium sorbate and malic acid and BHA/BHT were found to have some beneficial effect.

Dried fish, wrapped in polyethylene bags, were found to have better shelf life than fish kept in gunny bags without wrapping in polyethylene. Dried fish, kept at +13°C, was of better quality in all respects.

INTRODUCTION

Among the methods of long-term preservation of fish, solar drying may be regarded as the only possibility for the poor fishermen living in remote areas. Traditional drying in the sun, although widely practised, poses problems, such as slow drying rate, contamination with sand, insects, bacteria and overall poor quality. Solar drying systems have been improved by the development of different kinds of polyethylene tent driers in many countries of this region. In these systems the inside temperature is increased and the air flow accelerated by convection. As the temperature rises relative humidity inside the tent decreases. These effects accelerate the drying operation and higher temperatures (45°-50°C) help to control fly infestation.

BANGLADESH SITUATION

Sun drying is traditionally the principle method of fish preservation in Bangladesh. Drying is being done in about thirty different fields in the coastal areas during the winter season. About 25 000 t of fish is produced annually. A major problem with the traditional method is infestation by fly larvae which occurs in the process of drying, during storage in godowns and transportation (Ahmed, *et al.*, 1978).

A solar-tent drier was developed by Doe *et al.* (1977), as an attempt to solve the problems of conventional sun drying in Bangladesh. There was a joint venture between BCSIR, BAEC and Australia under the ASCA Programme[1/]. The drier, consisting of polyethylene sheeting on a triangular bamboo frame, proved successful in killing fly larvae and adult flies and an improvement in drying time was also obtained.

1/ Bangladesh Council for Scientific and Industrial Research; Bangladesh Atomic Energy Commission; Association for Science Cooperation in Asia

ASCA continued this Project with a joint project between Japan and Bangladesh for the improvement of drying systems and proper storage of solar-dried fish.

In field trials (in 1980), using PVC (misty) and polyethylene (clear) films in a tent-type drier, it was found that both films could effectively increase the drier temperature, but the clear polyethylene was more efficient, as expected. It was also noticed that the fish absorbing direct solar radiation becomes overheated and the temperature inside the flesh is much higher than the drier temperature, resulting in a cooking effect on the flesh.

In a further field trial (in 1981), the design of the drier was modified (rectangular type), keeping the drying shelves in the shade and preheating the inlet air through a solar head collecting device. The overheating and cooking effect could thus be avoided. However, the construction and the design of this drier were a bit complicated and the drier was not very stable in the windy conditions of the coastal area. In a later trial (in 1982), a hemicylindrical drier on a bamboo frame was developed, which proved to be satisfactory both in terms of stability and temperature.

Storage

In the traditional storage of dry fish in Bangladesh no proper measures are normally taken to protect the fish against unfavourable environmental conditions. The fish are normally kept in a godown without proper wrapping and packaging. They are at best packed in gunny bags or in bamboo baskets. In the humid months during the monsoon the average relative humidity in Bangladesh is over 85%. Dry fish in this period absorbs moisture from air, resulting in a high water activity which is favourable for fungal infestation. Insect infestation is also very common. Most of the fish are eaten up by insects, leading to heavy losses both in quality and quantity of the product. Oxidation of fat is also a common problem in dry fish storage.

In the present investigation attempts were made to test the effect of antioxidants and antifungal agents and different packaging conditions on the quality of the dry fish stored at room temperature (28°-30°C), and at a refrigerated temperature (+13°C) (Prabhu and Balachandran, 1981).

EXPERIMENTAL

Raw Material

Two varieties of fresh pomfret (*Stromateus chinensis* and *Stromateus cinereus*), locally known as rupchanda and folia chanda, of different sizes were selected for the solar-tent drying experiment at Cox's Bazar during the months of October 1981 and February 1982.

In the first trial, about 80 kg of fish was brought from BFDC (Bangladesh Fisheries Development Corporation) fish market and kept in ice in a chilled room before processing.

Salting

Fish were split dorsally, cleaned, washed and the entire quantity divided in seven lots for seven different treatments as follows:

(i) Ten kilos of fish was soaked over night in a solution containing 10% NaCl + 1% malic acid + 1% alum.; (ii) ten kilos of fish was soaked overnight in a solution containing 10% NaCl; the following was transferred to 1% potassium sorbate for 30 min, then 1% malic acid for another 30 min; (iii) eight kilos of fish was soaked overnight in a solution containing 10% NaCl + 2% sasutin A (BHA-suspension); (iv) ten kilos of fish was soaked overnight in a solution containing 10% NaCl + 0.3% BHA in rectified spirit (BHA salted out in brine); (v) ten kilos of fish was soaked overnight in a solution containing 10% NaCl + 1% Hypochlorite; (vi) ten kilos of fish was soaked overnight in a solution of 10% NaCl + 1% bleaching powder; (vii) fifteen kilos of fish was soaked overnight in a solution containing 10% NaCl as control.

In a later trial for drying, using the hemicylindrical drier, the whole lots of fresh pomfret were pre-treated with the following solutions:

(a) control - 10% NaCl
(b) antioxidants - 10% NaCl + 0.5% potassium sorbate + 1% BHT (anevitor)
(c) antifungal - 10% NaCl + 0.5% potassium sorbate + 1% malic acid

Drying

In the following morning the fish were transferred to the drier. Weight loss during drying period, temperature inside and outside the drier were measured (Table 1). Drying continued for 96 h and 48 h in the two different driers, respectively. The temperature history inside and outside the hemicylindrical tent is shown in Table 2.

Table 1

Changes in weight, moisture content and total volatile nitrogen during salting and drying

Batch 1

Time of drying (h)	Weight of fish (kg)	Moisture g%		TVN mg/100 g
		Wet	Dry	
Before salting	10.43	75.59	309.66	78.89
After salting 0 h	10.32	75.45	307.33	146.05
" " 24 h	7.20	64.53	181.92	352.29
" " 48 h	5.06	49.49	97.98	326.95
" " 72 h	4.19	39.85	66.25	390.07
" " 96 h	3.60	30.22	43.30	383.09
Batch 2				
Before salting	11.89	80.38	411.78	64.08
After salting 0 h	11.97	80.52	413.34	103.38
" " 24 h	5.08	52.78	116.35	262.63
" " 48 h	4.09	42.26	62.86	302.52

Storage

After the completion of drying at Cox's Bazar, all the dried fish were packed in cartons with an inside polyethylene wrapping. The fish were then brought to Dhaka.

After one month's storage at room temperature (around 30°C), visible fungal growth was observed in some lots of fish. All the samples were then redried for 6-7 h in the open sun to remove residual traces of fungi before further testing and storage.

One batch of sample, treated with antifungal agent, was then again sulphur-treated (by burning sulphur in a closed chamber) for approximately 3 h to see the effect of sulphur on the storage quality of fish.

All the samples were then divided into four batches for storage in two different temperatures, such as room temperature at about 28°-30°C and at refrigerated temperature at around +13°C. The temperature and relative humidity in the room is shown in Table 3.

Packaging

In both temperature regimes the fish were packed in two different ways for each pre-treatment.

One batch was unwrapped inside a gunny bag and the other was wrapped with polyethylene inside the gunny bag. The latter was again put inside a polyethylene bag so that outside air could not enter the bag. Samples were taken out after different intervals for the assessment of quality.

Table 2

Temperature history inside and outside of the tent during drying of pomfret

Drying time	Inside building		Outside tent		Inside tent (upper)		Inside tent (lower)	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
1st day								
09.00 h	23	26	24	29	33	38	29	32
11.00 h	24	28	24	31	44	50	38	42
13.00 h	24.5	29	25	34	43	50	40	44
14.00 h	24	30	25	35	43	50	39	43
15.20 h	22	30	23	32	44	49	45	47
16.10 h	23	29	23	31	41	44	41	43
2nd day								
09.00 h	21	25	21.5	27.5	35	39.5	30	33.5
11.00 h	21	28	21	31	41	50	36	40
12.00 h	23	28.5	24	33	43	51	39	43
13.00 h	22.5	30	23	32.5	42	52	40	45
15.00 h	22.5	30	23	32	41	49	42	45
16.00 h	22	30	22	31	38.5	45.5	41	43
3rd day								
09.00 h	22.5	25.5	22.5	28.5	33	38	29	33
11.30 h	23	28.5	23	33	43.5	53	39	44

Table 3

Ambient temperature and relative humidity of the room

Month	Minimum temperature (°C)	Maximum temperature (°C)	Average temperature (°C)	Relative humidity (%)
June	27.20	30.70	28.95	78.50
July	28.90	30.80	29.85	75.20
August	29.50	30.60	30.05	81.90
September	28.90	30.7	29.80	80.50
October	29.0	30.2	29.60	80.20
November	24.80	27.20	26.0	63.40
December	20.50	23.90	22.20	47.20
January	20.40	22.60	21.50	44.40
February	22.20	24.70	23.45	58.50
March	25.20	28.0	26.60	72.60
April	27.80	30.50	29.15	79.60
May	27.0	30.70	28.85	84.30

Quality Evaluation

For the organoleptic assessment of fish quality, a test panel consisting of 6-7 members, tested the fish samples before and after cooking for general appearance, odour, flavour and any visual fungal infestation, texture and overall acceptability. Total volatile nitrogen and moisture content were determined as biochemical parameters of quality of the dry fish. Composite samples of fresh fish, before brining and after splitting and during drying from each treatment, were taken out of preparing TCA extracts. The TCA extracts of the fish were analysed to determine the total volatile nitrogen (TVN) according to the Conway Microdiffusion Technique (Conway and Byrnee, 1933, modified by Person, 1962).

Proximate Composition

Moisture protein, ash and salt content of the dry pomfret was determined by the method of AOAC. Approximate water content of the fish during drying was calculated from the moisture content of the final product (Table 4).

Table 4

Proximate composition of dried pomfret after different pre-treatments

Batch 1

Pre-treatments	Moisture (g%)	Protein (g%)	Ash (g%)	Salt (g%)
10% NaCl + 1% malic acid + 1% alum.	28.09	72.69	3.7	14.8
10% NaCl + 1% pot. sorbate + 1% malic acid	30.90	72.77	2.6	14.06
10% NaCl + 2% BHA	32.36	71.72	4.27	15.03
10% NaCl + 0.3% BHA	31.56	69.88	4.37	18.67
10% NaCl + 1% hypochlorite	28.84	63.31	3.81	17.73
10% NaCl + 1% bleaching powder	29.82	66.51	5.35	12.83
10% NaCl - control	29.98	64.51	3.16	18.25
Batch 2				
Control - 10% NaCl	43.47	-	-	-
10% NaCl + 0.5% pot. sorbate + 1% BHT	44.66	-	-	-
10% NaCl + 0.5% pot. sorbate + 1% malic acid	38.67	-	-	-
Control - 10% NaCl + sulphur-treated	38.10	-	-	-

RESULTS

Changes During Drying

Changes in the moisture content and the total volatile nitrogen were determined during drying. Although moisture content dropped gradually, the TVN value (Tables 1 and 3) continued to rise, which also increased during pre-treatment. However, during storage the TVN figure showed a positive correlation with the moisture content of the product (Table 5).

Table 5

Correlation coefficient between moisture content and TVN in the dry fish product

Batch 1

Pre-treatments	Correlation coefficient (r)
A. Antifungal	
NaCl + malic acid + alum.	0.34
NaCl + malic acid + potassium-sorbate	0.69
NaCl + hypochlorite	0.47
NaCl + bleaching powder	0.42
B. Antioxidants	
NaCl + BHA (2%)	0.71
NaCl + BHA (0.3%)	0.96
C. Control	
NaCl	0.35
Batch 2	
Control	
NaCl	0.43
Antifungal	
NaCl + potassium-sorbate + malic acid	0.88
Antioxidants	
NaCl + potassium-sorbate + BHT 1%	1.32

Effect of Pre-treatments

The organoleptic effects of pre-treatment on the final product are shown in Table 6.

Antifungal agents - From an assessment of the quality of the stored product it was found that fish pre-treated with a mixture of salt, malic acid and alum., as well as fish treated with salt and bleaching powder as antifungal agents, were unacceptable to the panel members in respect of texture, flavour and odour. These samples also showed some fungal infestation after storage at the room temperature.

Treatments with hypochlorite resulted a product which was moderately acceptable to the panel after storage.

The samples treated with a mixture of potassium-sorbate and malic acid were highly acceptable before storage but moderately acceptable after storage.

Antioxidants - Fish treated with BHA was acceptable to the panel and BHA (0.3%) was considered best among all the treatments.

Table 6

Effect of pre-treatments, packaging and storage condition on the quality of dry fish

Batch 1

Pre-treatments	Storage condition	Storage time (month)	Packaging	Overall acceptability
A. Antifungal agent				
NaCl + malic acid + alum.	Room temperature (28°-30°C)	1	Carton boxes	Just acceptable
	" "	8	Gunny bag	Highly unacceptable
	" "	8	Polyethylene bag	Moderately unacceptable
	+ 13°C	12	Gunny bag	Acceptable
	+ 13°C	12	Polyethylene bag	Acceptable
NaCl + pot. sorbate + malic acid	Room temperature (28°-30°C)	1	Carton boxes	Highly acceptable
	" "	8	Gunny bag	Moderately unacceptable
	" "	8	Polyethylene bag	Moderately unacceptable
	+ 13°C	12	Gunny bag	Moderately acceptable
	+ 13°C	12	Polyethylene bag	Moderately acceptable
NaCl + hypochloride	Room temperature (28°-30°C)	1	Carton boxes	Acceptable
	" "	8	Gunny bags	Moderately acceptable
	" "	8	Polyethylene bag	Moderately acceptable
	+ 13°C	12	Gunny bag	Acceptable
	+ 13°C	12	Polyethylene bag	Acceptable
NaCl + bleaching powder	Room temperature (28°-30°C)	1	Carton boxes	Moderately unacceptable
	" "	8	Gunny bag	Unacceptable
	" "	8	Polyethylene bag	Unacceptable
	+ 13°C	12	Gunny bag	Unacceptable
	+ 13°C	12	Polyethylene bag	Moderately unacceptable
B. Antioxidants				
NaCl + BHA(2%)	Room temperature (28°-30°C)	1	Carton boxes	Acceptable
	" "	8	Gunny bag	Acceptable
	" "	8	Polyethylene bag	Acceptable
	+ 13°C	12	Gunny bag	Highly acceptable
	+ 13°C	12	Polyethylene bag	Highly acceptable
NaCl + BHA(0.3%)	Room temperature (28°-30°C)	1	Carton boxes	Moderately acceptable
	" "	8	Gunny bag	Acceptable
	" "	8	Polyethylene bag	Acceptable
	+ 13°C	12	Gunny bag	Highly acceptable
	+ 13°C	12	Polyethylene bag	Highly acceptable
C. Control				
NaCl (10%)	Room temperature (28°-30°C)	1	Carton boxes	Acceptable
	" "	8	Gunny bag	Just acceptable
	" "	8	Polyethylene bag	Moderately acceptable
	+ 13°C	12	Gunny bag	Acceptable
	+ 13°C	12	Polyethylene bag	Highly acceptable
		Batch 2		
A. Antifungal agent				
NaCl + pot. sorbate + malic acid	Room temperature (28°-30°C)	1	Carton boxes	Moderately acceptable
	" "	6	Gunny bag	Unacceptable
	" "	6	Polyethylene bag	Unacceptable
	+ 13°C	6	Gunny bag	Acceptable
	+ 13°C	6	Polyethylene bag	Acceptable
B. Antioxidants				
NaCl + pot. sorbate BHT	Room temperature (28°-30°C)	1	Carton boxes	Acceptable
	" "	6	Gunny bag	Just acceptable
	" "	6	Polyethylene bag	Acceptable
	+ 13°C	6	Gunny bag	Acceptable
	+ 13°C	6	Polyethylene bag	Acceptable
C. Control				
NaCl	Room temperature (28°-30°C)	1	Carton boxes	Highly acceptable
	" "	6	Gunny bag	Acceptable
	" "	6	Polyethylene bag	Highly acceptable
	+ 13°C	6	Gunny bag	Highly acceptable
	+ 13°C.	6	Polyethylene bag	Highly acceptable
NaCl + sulphur treated	Room temperature (28°-30°C)	1	Carton boxes	-
	" "	6	Gunny bag	Just acceptable
	" "	6	Polyethylene bag	Just unacceptable
	+ 13°C	6	Gunny bag	Highly acceptable
	+ 13°C	6	Polyethylene bag	Highly acceptable

Control - Simple brine treated samples as a control were highly acceptable before storage, but after storage just acceptable.

Effect of packaging material - Polyethylene wrapped fish retained normal dry fish odour and flavour. Rupchanda were darker than the folia chanda among the two groups. Control group rupchanda had stronger rancid odour than the folia chanda of the same group.

Fish kept in a gunny bag without wrapping in polyethylene was wet in the humid seasons and, on the other hand, polyethelyne wrapped fish was nice and dry. Polyethylene wrapped samples in general had slightly more dried-fish odour and flavour than the unwrapped samples in all the cases.

Effect of Storage Temperature

The samples stored at +13°C were found to be of the best quality in all cases. There was no significant difference in quality between wrapped and unwrapped samples at this temperature.

No fungal growth was observed in any of the samples. On the other hand, the samples stored at room temperature were heavily infected with fungi and was highly unacceptable to the panel.

Major Observations

- Treatment with antifungal agent did not result any beneficial effect.
- Treatment with antioxidants improves the quality.
- Polyethylene-wrapped fish kept better than the unwrapped ones.
- Fish stored at +13°C was superior in all cases.

CONCLUSION

The desirability of storing dry fish (which is an expensive commodity and source of protein), in cold storage deserves special attention. If, however, dry fish is to be stored at room temperature, it would be properly wrapped in moisture proof packaging materials.

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DRIED FISH IN EAST JAVA, INDONESIA

by

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ABSTRACT

Investigations were undertaken to improve the quality of dried fish through improvement of processing methods. The present stage of research indicated that too salty dried fish is highly susceptible to weather fluctuation. Dried fish with moderate salt and moisture contents, on the other hand is easily spoiled by microbes. In drying experiments, a constant weight of 46.7% of the initial weight was reached after a process of approximately 26 h under favourable weather conditions. In another experiment a dryer was designed. At present, however, this dryer has not produced a satisfactory dried fish with the desired salt and moisture content.

INTRODUCTION

Fish supplies more than three quarters of the animal protein consumed in Indonesia with half of this amount coming from fish processed by traditional methods. In Java, a particular fish consumption is sustained bringing in fish from other islands. Fish belongs to a group of nine essential, food items together with rice, sugar, etc., and therefore, apart from its potential as a source of foreign exchange, it plays an important role in nutrition and health of the people.

There are many techniques of traditional processing which vary from one area to another. The quality of raw material determines how much improvement can be made in the end product. Although poor handling practices are prevalent, better quality and general hygiene of fish products require improvement of all aspects of the fish industry including harvesting, handling, processing, distribution and marketing.

Traditional fish drying processes rely on sun and wind as abundant sources of energy, and new drying techniques and equipment should be designed and constructed to avoid expensive energy such as kerosene and wood for fuel. Excess use of such fuel could destroy the environment as well as be too expensive.

Cooperation between the Department of Food Science and Technology of Brawijaya University in Malang (Indonesia) and the International Development Research Centre (IDRC) (Canada) was established to work an improvement of drying techniques, such as the use of rice husks as fuel for drying sardines.

DRIED FISH AND ITS PROBLEMS

Production

The chain of activities beginning from catching through to marketing is too long and is often disrupted, ruining the quality of fishing, spoilage, contamination and breakage.

In 1979, total fish production was 1 317 744 t, of which 47.38% was marketed as fresh fish, 48.86% traditionally processed, 2.77% frozen, 0.65% canned, 0.34% as fish meal (Table 1).

Drying and salting were the two traditional processes which were widely practised in almost every province in Indonesia. Fish processed in these ways constituted 35.69% of the total production of fish processed traditionally, contrasted to boiled or "pindang", 5.78%; fermentation, 4.55%; smoked, 2.12%; other methods, 0.72%.

Fish production from East Java amounted to 63 854 t, of which 34 404 t or 53.88% was dried fish, 30.60% boiled or "pindang", 2.42% smoked, 3.24% by other unspecified methods of processing, the rest by being frozen, canned and fish meal (Table 2).

Problems Related to Processing

Each processing method yields a certain end product having a particular quality which generally depends on conditions such as temperature, moisture, and the chances of suffering from biological recontamination, physical damage, or chemical reactions which can lead to denaturation and spoilage.

The following reasons cause variable quality of fish products from traditional processing:

(i) low freshness of fish due to limited transportation facilities either at sea or on land;

(ii) poor sanitary and hygienic conditions due to insufficient freshwater supplies;

(iii) in sun drying no racks or supports are used to reduce contamination from the surroundings;

(iv) use of salt of low purity (occasionally waste salt) (see Table 3). This kind of salt besides having an unfavourable penetration speed also affects the colour and appearance of the end product;

(v) ratio of fish and salt is: one or two parts of fish to one part of salt. Salting time varies from 12 to 48 h, producing a dried product containing a salt content of 22.34% to 32.91%, sometimes as high as 37.59% in fermented fish of "pedo" (Table 4).

(vi) fish rich in fat such as sardine is immersed in saturated salt solution 24 to 48 h to lower the fat content. This long salting process results in high salt levels.

A survey of dried highly salted products in the market of Malang revealed that:

(i) quality was extremely affected by the weather conditions. In humid weather the surface of the fish became watery and felt wet. When the weather grew dry the surface was covered with salt crystals which felt sandy. The consumers disliked the appearance;

(ii) the local consumers in East Java disliked too salty dried fish, which meant that consumers' protein intake was much affected. This fish, thus, had to be marketed outside East Java, consequently increasing the time and cost of transportation and reducing the storage period left to the sellers.

Sun Drying Experiments

Based on facts from investigation and market survey an experiment on drying fish was carried out in cooperation with local processors in Muncar, by two separate groups both using the same procedures.

This experiment was intended to discover the "critical points" of traditional procedures which have an important role on quality of end product.

Sardine of average lenght of 18.35 cm and 54.30 g, average weight were beheaded, scaled and gutted. Salting was by mixing of 4 kg of fish with 2 kg of salt, and sufficient water for complete immersion for 48 h.

Sun drying lasted for three days, about three to four hours in every day due to unfavourable weather in January. Samples were then analysed for total bacterial count; TVB; moisture and salt content; and organoleptic test. Statistical analysis indicated that there were no significant defferences between the product from the local processor and the project team.

Another experiment on drying procedures was conducted in Muncar. The fish was dried under the sun for nine hours a day for as long as three successive days, until the fish reached a constant weight. Table 5 records the drying process.

A dryer was then built in Muncar, which is the centre of fishery in East Java. This followed the design of a dryer built in Malang, but with slight modification. The technical data of the two dryers are shown in Table 6.

The Muncar dryer was provided with a ventilator of 20 x 30 cm installed in the rear section of the heat exchanger and the air-duct in order to regulate the air temperature in the cabinets by means of opening or closing the ventilator at constant diesel speed ant constant rice husk burning. In an experiment with this dryer a period of 24 h was need to reach constant weight of sardines of about 110 mm length which had been salted in a traditional method. Table 7, indicates the events during this experiment.

Another experiment used fish of 136-152 mm total length 22.3-30.6 g in weight. However, this was not successful as when the temperature increased above 40°C, fat was extracted from the fish flesh causing it to look "wet". According to the processors fish in that condition should be cooled to avoid the oil exuding from the flesh to the surface. Normally the processors also avoid it by prolonging the salting time.

According to processors' experience, when signs of oil extraction appeared during the drying process (locally termed "gosong") resulting from too high temperature, the dryer should be cooled off to prevent damage to the fish. Fish which have been soaked in saturated salt solution for over 24 h do not undergo spoilage during the drying process. On the other hand, if the salting period is less, spoilage is very likely to occur before the fish reached the desired dryness. Therefore, one alternative is to follow the methods used by the processor, that is to soak the fish in satured salt solution until oil content was low enough.

Unfortunately the result is dried fish with a hig salt content. Methods to produce fish products with less salt, that would cater for the local consumers' preferences, still have to be found, especially with fish high in oil such as sardine.

CONCLUSION

In artificial drying, salting methods followed by the processors, especially when processing fish with high fat content should be taken into account. Each method entails different technical aspects such as soaking time, sanitation, temperature, drying time, and operational cost etc.

Table 1

Sea fish production in Indonesia in 1979

Specification of processing	Total production (t)	(%)	East Java production (t)	(%)
1 Fresh consumption	624 350	47.38	35 040	26.52
2 Dried (salted) fish	470 343	35.69	54 949	41.58
3 Boiled fish	76 151	5.78	26 795	20.28
4 Fermentation :				
a) Balacan	53 860	4.09	1 324	1.00
b) Fermented fish (pedo)	5 650	0.43	874	0.66
c) Fish souce	482	0.04	-	-
5 Smoked fish	27 986	2.12	2 230	1.69
6 Others (unspecified)	9 449	0.72	2 869	2.17
7 Freezing	36 439	2.77	1 758	1.33
8 Canning	8 540	0.65	4 165	3.15
9 Fish meal	4 494	0.34	2 145	1.62
Total production	1 317 744		132 149	

Source: Fisheries Dept. Statistic,1979

Table 2

Processed fish production in Indonesia in 1979

Specification of processed fish	Total production (t)	(%)	East Java production (t)	(%)
1 Dried (salted) fish	281 775	64.00	34 404	53.88
2 Boiled fish	59 350	13.48	19 538	30.60
3 Fermentation :				
a) Balacan	32 722	7.43	878	1.38
b) Fermented fish	4 121	0.94	627	0.98
c) Fish souce	425	0.10	-	-
4 Smoked fish	19 055	4.33	1 547	2.42
5 Others (unspecified)	6 871	1.56	2 070	3.24
6 Frozen fish	29 594	6.72	1 707	2.67
7 Canned fish	5 174	1.18	2 558	4.01
8 Fish meal	1 209	0.27	525	0.82
Total production	440 296	100	63 854	100

Source: Fisheries Dept. Statistic, 1979

Table 3

Chemical composition of salt

Chemical substances	Brickette salt (%)	Traditional salt (%)	Used salt (%)
NaCl content	90.82	82.65	81.57
Ca content	0.142	0.0723	0.2773
Mg content	0.156	0.1153	0.3766
Fe content	0.014	0.0201	0.0440
SO_4 content	0.2030	0.3304	0.1961
Iodine content as JO_3	0.0	0.0	0.0

Source: Laboratorium Kesehatan Daerah Surabaya (1981)

Note: heavy metals and cyanide were absent in all samples

Table 4

Salt and moisture content of dried fish in Muncar

Species	Handling	Salt content (%)	Moisture content (%)
Semenit/samll sardine	Whole fish	22.34	44.56
Kurisi (*Holocentrum* spp.)	Gutted	29.02	51.15
Tembang (*Sardinella* spp.)	Whole	30.89	48.04
Selar (*Caranx* spp.)	Whole	32.91	45.85
Layang (*Decapterus* spp.)	Whole/fermented	37.29	49.55
Selar (*Caranx* spp.)	Whole/fermented	37.59	48.78
Kurisi (*Holocentrum* spp.)	Whole	29.02	51.15
Kurisi (*Holocentrum* spp.)[a/]	Gutted	31.67	48.57

a/ Processed to a high salt content

Table 5

Data of weight and the drying condition in Muncar during the experiment

The first day.

Observation	1	2	3	4	5	6	7	8	9
Time	08.00	09.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00
Weight (g)	1000	858.75	807.75	775.25	741.25	705.75	687.65	671.00	656.50
Temperature (°C)	28	30	31	36	38	34	30	30	29
Rel.Humid. (%)	61	51	48	44	36	36	44	47	43
Air Vel.(m/sec)	1.5	1-2	1-2	1.5-3	0.5-1.5	1-1.8	1-1.8	1-2	0.8-1.4

The second day.

Observation	1	2	3	4	5	6	7	8	9
Time	08.00	09.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00
Weight (g)	656.00	638.50	623.00	608.20	590.00	580.75	570.00	561.50	555.75
Temperature (°C)	25	31	33	29	29	29	33	30	28
Re.Humid. (%)	72	56	53	42	43	44	45	50	58.50
Air Vel. (m/sec)	0.5-1.3	0.5-1.5	0.6-1.3	0.6-1.3	1-2	1.4-2.6	1-2	1.4-1.8	1.8-2.6

The third day.

Observation	1	2	3	4	5	6	7	8	9
Time	08.00	09.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00
Weight (g)	557.5	555.7	548.0	536.0	522.70	511.0	501.0	493.0	489.0
Temperature (°C)	25	27	30	32	33	42	36	33	35
Rel.Humid. (%)	83	71	66	51	42	35.3	41	45	43
Air Vel. (m/sec)	0.2-0.8	0.4	0.8-1.4	0.5-1	1.5-2.3	0.5-1.8	0.5	0.2-0.8	0.5-0.8

Table 6

Technical data of the dryer

	First dryer	Second dryer
Capacity	1 000 kg	1 000 kg
Number of cabinets	5	5
Diesel engine power	5 hp	8 hp
Water (coolant)	5 litre/h	running system
Rice hust consumption	2 kg/h	3 kg/h
Diesel fuel consumption	0.25 litre/h	0.4 litre/h
Maximum temperature	74°C	74°C
Maximum air velocity	60.7 m^3	90 m^3
Temp. variation in Cabinet I - V	30-31°C	50-59°C

Table 7

Data of weight and the conditions in the dryer during the experiment

Drying time (h)	0	2	4	6	8	10
Weight (g)	1 900	1 665	1 558	1 466	1 375	1 284
Temperature (°C)	27-35	32-38	31-39	35-42	39-43	38-41
Rel. humidity (%)	48	46-48	40-46	68-54	45-43	45-40
Air velocity m/sec	-	-	-	-	0.8	0.8-0.85

Drying time (h)	12	14	16	18	20	22	24
Weight (g)	1 197	1 126	1 052	1 018	972	946	916
Temperature (°C)	38-43	29-43	28-40	30-37	31-42	27-37	29-36
Rel. humidity (%)	36-38	60	55-62	56-58	50-60	62-66	65-68
Air velocity m/sec.	0.8	0.85	0.88	0.85	0.85	0.8	0.8

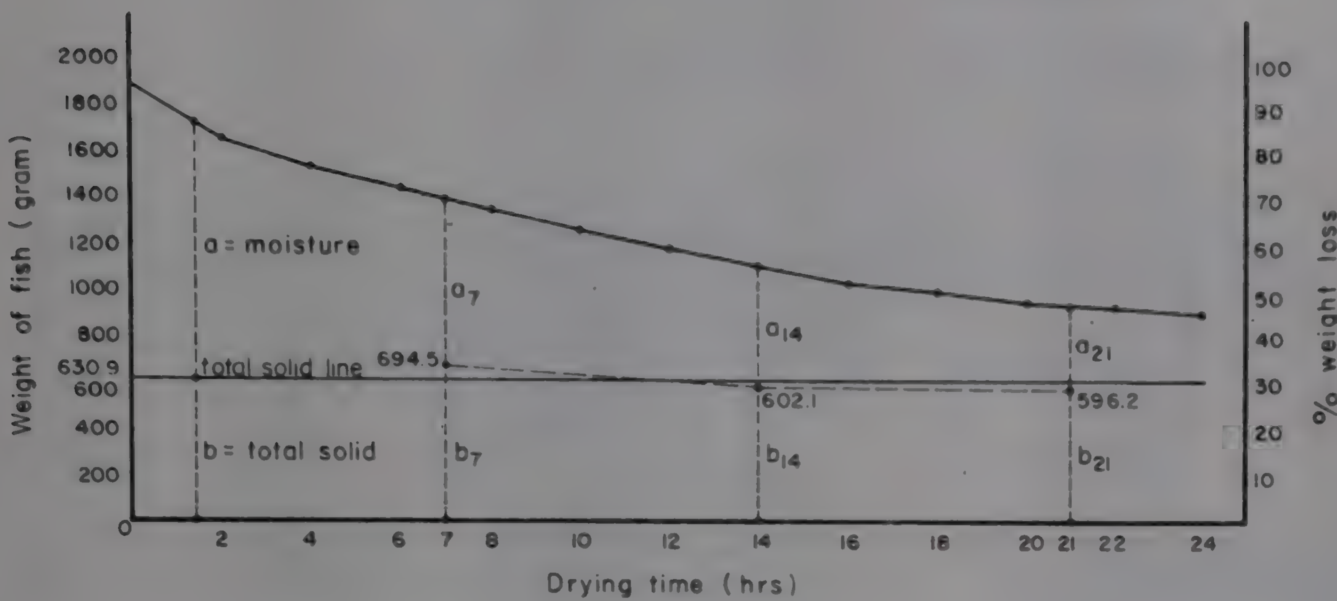


Fig. 1 DRYING CURVE OF FISH USED THE DRYER

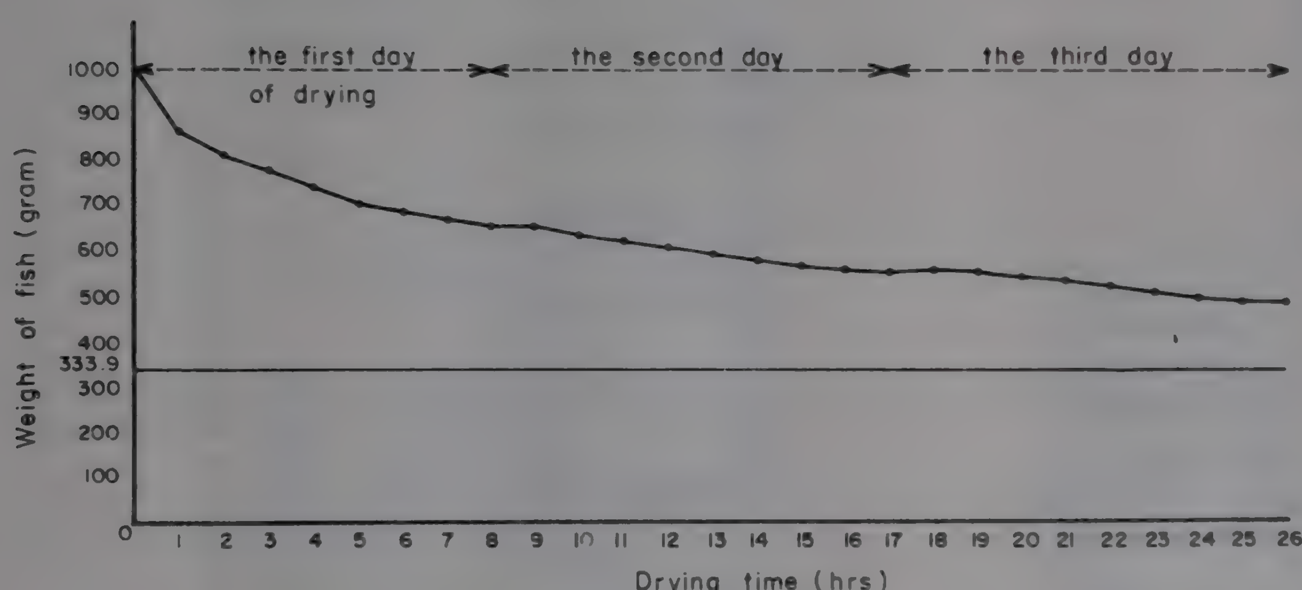
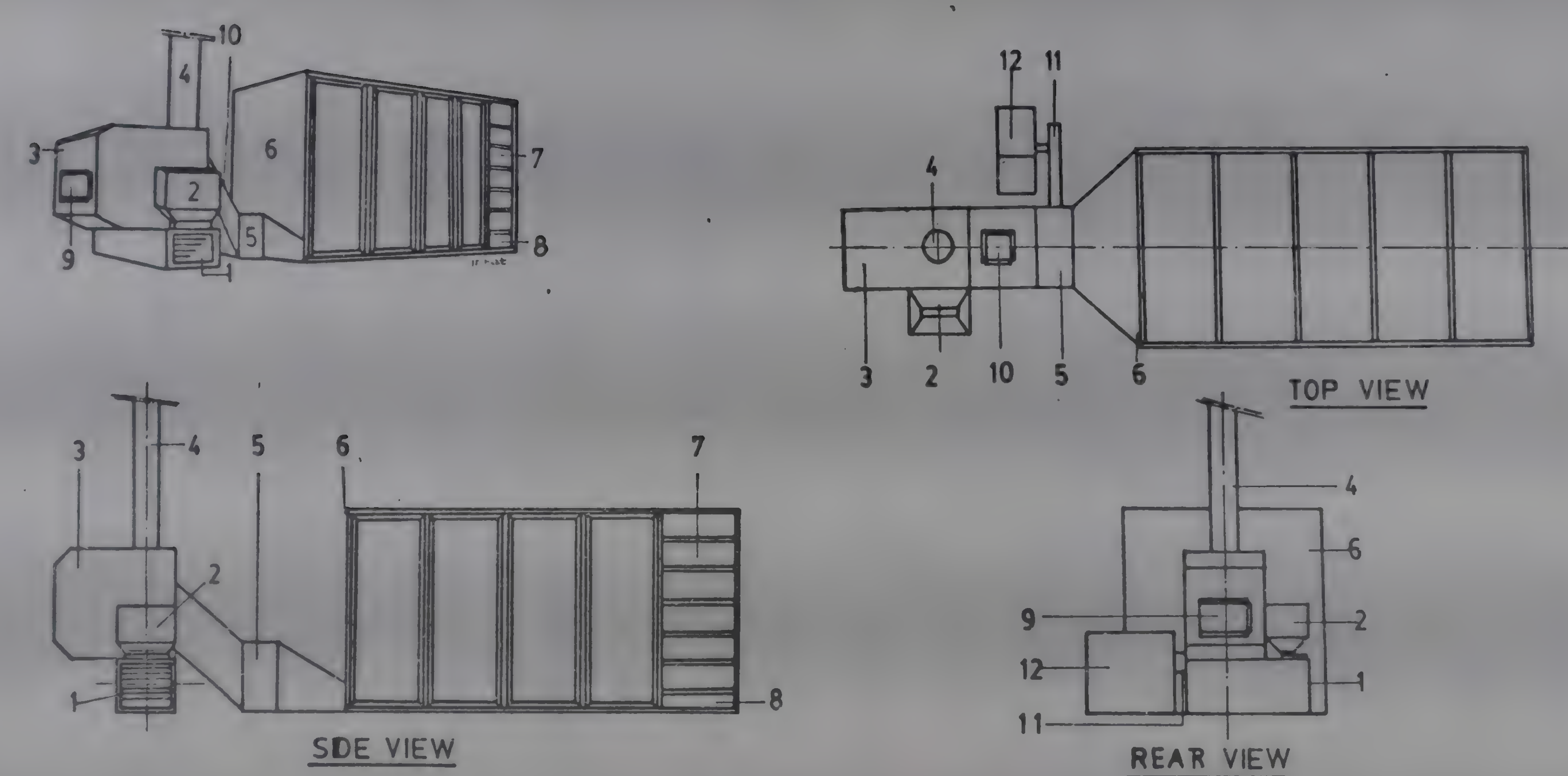


Fig. 2 THE DRYING CURVE OF THE TRADITIONAL PROCESS (Sun-drying)



1 BRICK FURNACE IRON GRATING
2 RICE HULL HOPPER
3 TWO DRUM TUBULAR HEAT EXCHANGER
4 CHIMNEY
5 BLOWER FAN CHAMBER, DRIVEN BY 8 HP DIESEL MOTOR
6 PLYWOOD CABINET
7 BAMBOO TRAYS
8 PLENUM WITH GI SHEET BUFFLES
9 VENTILATOR OF REAR SECTION OF HEAT EXCHANGER
10 VENTILATOR OF AIR DUCT
11 V - BELT
12 8 HP DIESEL MOTOR

ADAPTATION OF ARTIFICIAL FISH DRYING TECHNOLOGY IN THE PHILIPPINES

by

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ABSTRACT

A survey of the Philippine fish drying industry revealed a number of environmental, technical and governmental problems. An artificial dryer burning rice hulls was designed and tested before installation in Mercedes. The processors have been receptive to the new technology, particularly during bad weather.

1. INTRODUCTION

Fish in every form (fresh frozen, dried smoked or salted) is part of the traditional Filipino diet because of its high protein content. While it is ideal for consumers to eat fresh fish, seasonal shortage induces entrepreneurs to preserve fish by drying. Generally, the dried fish industry encounters no difficulty in marketing its produce, since consumers, together with exporters, purchase as much as dried fish as the processors can produce. Prices have risen in recent years even with competition from other fish products.

Using the 1965-75 figures, annual dried fish demand was placed at about 58 300 tons, increasing at a rate of two tons each year. The average gap of demand against supply is conservatively estimated at 195 tons, increasing by 46 tons annually. Local production is not able to meet this demand[1/]. Main species and prices are shown in Table 1.

2. PROBLEMS OF THE FISHING INDUSTRY

The fish drying industry in the Mercedes area has a number of problems which are common to other fish drying communities. Among the problems gathered during a survey are:

(a) highly seasonal nature of production and fluctuating supply causing economic insecurity among processors;

(b) variable quality of fish when landed due to lack of proper handling on-board the fishing vessel;

(c) lack of proper cold storage facilities in fish landings and processing plants. Although small processors do not greatly feel this problem, medium and large scale operators do;

(d) considerably time is required for pre-drying preparation of fish products. Preparation takes 4 to 6 hours, depending on the skill of the worker and type of fish;

(e) unpredictability of the weather for sun drying;

1/ Department of Natural Resources, Dried Fish Investment Project Profile 1977

(f) sun drying usually takes 1 to 2 days under good weather conditions. Prolonged exposure of the fish to conditions favorable for autolysis and microbiological activity lowers the quality of salted fish and consequently of the dried fish;

(g) lack of quality control and sanitation in fish processing establishments since the processors main concern is increasing volume of production.

Geographical location and physical attributes makes the Philippines a natural fishing ground, surrounded by coastal towns and barrios engaged in fish processing, mainly fish drying. If such vast marine and inland water resources of the country are efficiently developed and properly managed, the Philippines will not only be able to meet its fish requirements on a sustained basis but could also become a major fish producing country, both in fresh and processed form.

The problems of the fish industry can be categorized into environmental, technical and governmental. In the technical aspect of the problems, the use of artificial dryer can be a solution as the dependence of processors on favourable weather would be minimal. There would also be less lag time between preparation and drying of fish thus producing good quality dried fish.

The use of artificial fish dryers is a new concept to the processors since there is no existing artificial dryer in commercial operation. The dryers described in the paper are a product of a series of developmental changes of earlier models used and tested at DFST, UP at Los Baños. The high cost of operation using fossil based fuel has led to the reorientation of design towards the use of non-conventional heat sources (Table 2).

The single drum furnace and heat exchanger has evolved into the present brick furnace with double multi-tube drum heat exchanger. The column of five trays stacked one on top of the other over a rectangular plenum has been converted into a chamber with baffles and 10 maindoors. The 12 inch blower has been changed to a more powerful 24 or 36 in axial blower. And finally whenever electricity is available the 5 to 7 hp gasoline engine was replaced by a 1 to 1.5 hp electric motor.

Table 2

Energy cost equivalent

Energy Source	Heating Value (BTU/lb)	Unit Cost (P.Ps./lb)	Fuel Cost/t (P.Ps.)
Gasoline	18 500	2.6484	308.88
Kerosine	18 500	1.3329	163.85
Diesel	18 500	1.4204	174.61
Fuel Oil	17 755	.9041	115.80
Coal	12 500	-	-
Ricehull	6 000	.0183	6.93
Sawdust	8 000	.0366	10.40

TECHNICAL DESCRIPTION OF THE DRYER

The UPLB-IDRC Fish Dryer (Fig. 1) is composed of four major parts namely the furnace, the heat exchanger, the blower and the drying chamber. The furnace is made up of bricks, supported by angle bar framing. It has a burning area of 836 in^2 and can reach a maximum temperature of 1 500°C. A double multi-tube drum heat exchanger is located on top of the furnace connected by a duct and heats air to a temperature of 60°-70°C. The heated air is then sucked by a 24 in blower driven by a 1.5 hp electric motor. It can deliver 5 400 cfm of heated air, consuming 0.56 kW of electricity/hour.

Table 1

Characterization and wholesale price per kilo of the common fresh fish species used for drying

Species of fish	Average size (cm)	Fat content	Outer skin	Price of Fish (P.Ps.)		
				Low	High	Average
1. Anchovies	5	lean	without scales	10.00	12.00	11.00
2. Herring	10	lean	with stiff scales	7.00	10.00	8.50
3. Sardines	14	medium fat	with soft scales	7.00	12.00	9.50
4. Slipmouth	10	medium fat	without scales	6.00	8.00	7.00
5. Roundscads	12	lean	without scales thin and soft skin	8.00	10.00	9.00
6. Nemipterid	18	lean	with very thick scales and thick skin	12.00	14.00	13.00
7. Squid	12	lean	thick and compact meat	20.00	30.00	25.00
8. Mackerel	14	medium fat	without scales, thin skin	10.00	14.00	12.00

The drying chamber has 10 doors and five compartments. Its plenum is provided with baffles which can be adjusted depending on what and how many compartments are to be operated. The baffles also promote uniform distribution of heated air between the operating compartments. The dryer is designed to move air across the product at a velocity of 1 ft/sec and a temperature of 50°-60°C. To obtain uniform temperature distribution within the chambers, adjustable exhaust vents are placed on top of each chamber to provide positive resistance to the air flow.

Using rice hulls as fuel, an average of 25 kg or two sacks are consumed every hour to maintain a temperature of 40°-60°C at full capacity. Drying time ranges from 8 to 12 hours during good weather and 10-16 hours during rainy days and night operation.

At normal ambient temperatures of around 30°C chamber temperatures between 50°C and 60°C may be obtained. During rainy days and night operations when ambient temperatures can fail as low as 26°C, the chamber temperature also decreases to about 40°C. This is due to increased heat losses when the temperature gradient between the dryer and the surroundings is high.

Lean fish may be dried quickly at temperatures as high as 50°-60°C. For fatty fish like the sardinella drying temperature has to be lowered so as to avoid the release of fats and to promote uniform drying. The air velocity must also be controlled together with temperature to avoid too much stress and cooking of the fish product.

FURTHER TESTING FOR DRYER PERFORMANCE

During operation data or wind velocity motor rpm, kilowatt-hours consumed and temperature distributions were collected to monitor the operation of the fish dryer under commercial operation. Upward wind velocities were taken at different parts on the tray. Results showed an uneven wind flow distribution. This unevenness may be attributed to uneven tray loading. In this connection, the arrangement of the fish on the trays was considered a factor.

Temperature readings within the drying chamber were monitored by level as well as by compartments. Figure 2 shows readings of temperature at four levels in the first compartment. Temperatures were graphed by compartments and by levels to show the variation as heated air was distributed. The variation is attributed to the changes in furnace condition. Temperature fell with distance of compartment from the furnace.

A graph of the temperature against time shows variation in the temperature distribution. This variation is attributed to the changes in the furnace condition. To maintain a more or less constant chamber temperature of 55°C it is important that the combustion within the furnace be maintained at 1 500°C.

Drying Time and Fuel Consumption

The total drying time was about 11 1/2 hours. After six hours of operation however, fish near the bottom of the chamber may already be removed. After about two more hours, a second removal may be done. The fish located at the topmost trays took a much longer time to dry. The drying process consumed 20 sacks of ricehull for the furnace and 6.3 KWH electricity (this included the consumption of the motor and two 60 W light bulbs). On an hourly basis, the consumption was 1.74 sacks of ricehull and 0.542 kW of electricity.

Wind Distribution

Each tray was divided into 18 areas where upward wind velocities were taken. The wind distribution were uneven. Result showed that in some areas of the tray, velocities were negligible, although the average was 34.67 fpm. The uneven wind distribution was attributed to the non uniform tray loading and hence varying resistances to air flow. This prompted a redesign of the chamber and the addition of roof vents to serve as positive resistance to the wind.

During these fishing season in Mercedes, a relatively low volume of catch was observed. Fisheries officers attributed this to the destruction of the natural habitat of the fish and to the uncontrolled fishing. With the improvement of the road and consequent increase in number of wholesale traders of fish, an increase in price of fish was observed which

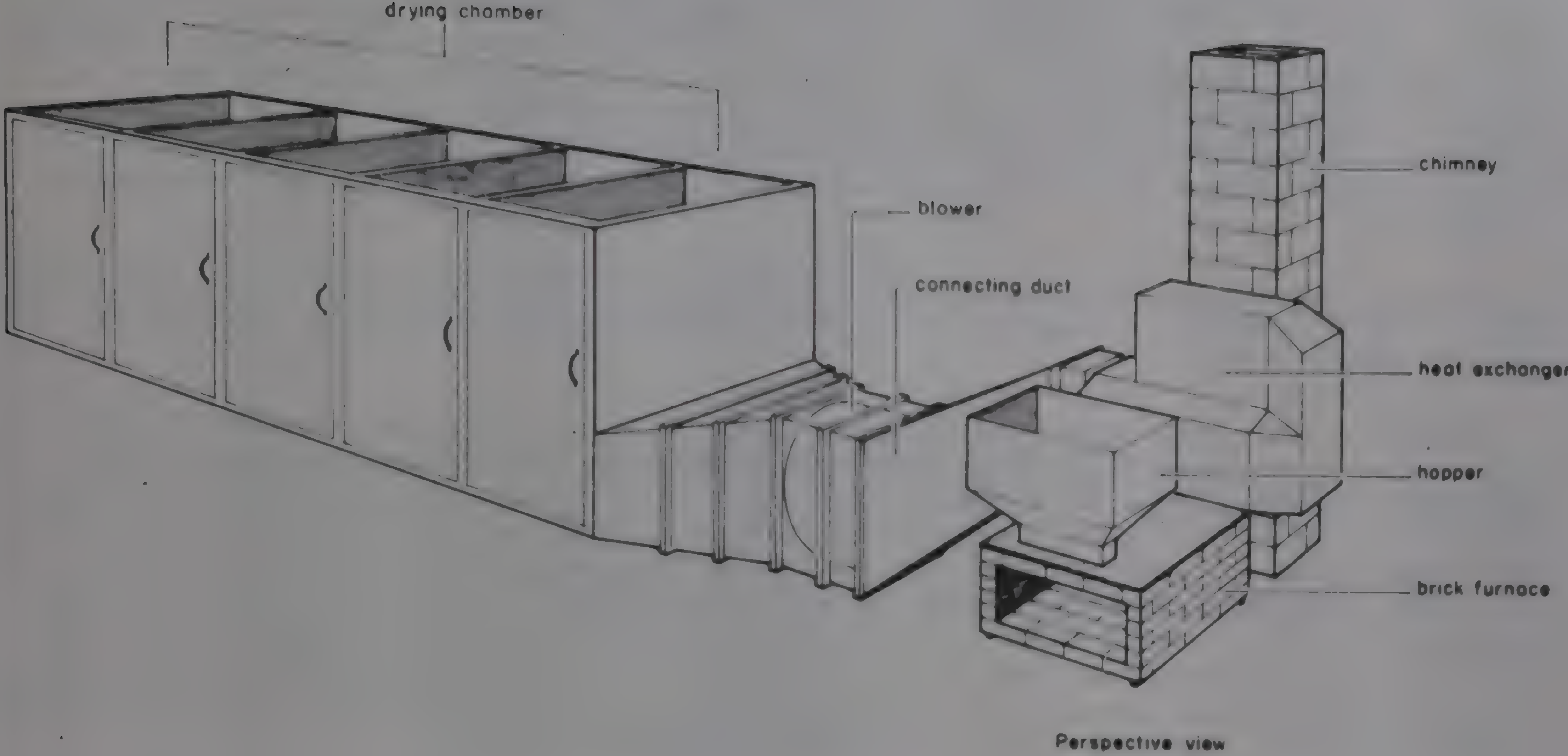

Fig. 1 RICEHULL-FIRED FISH DRYER

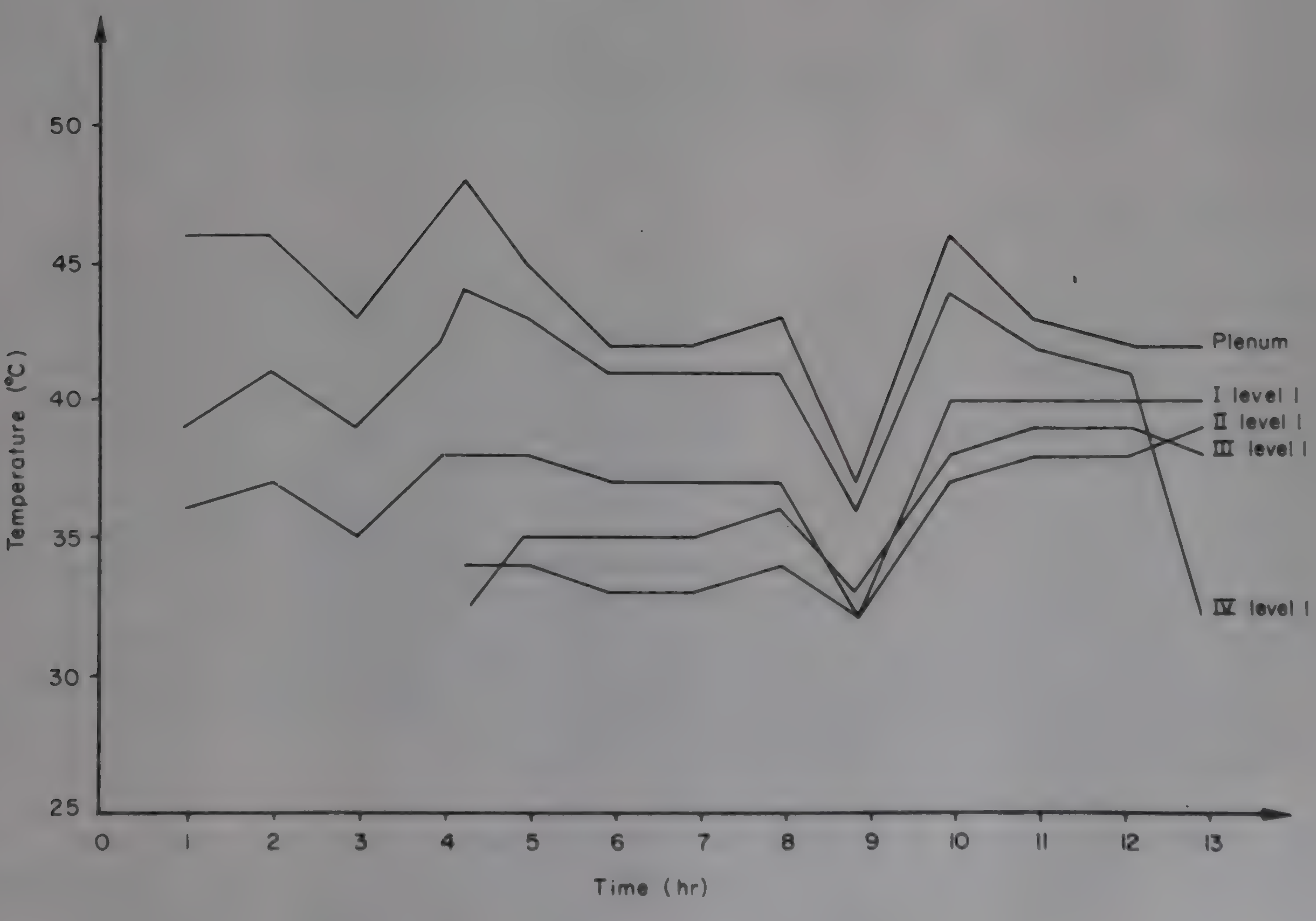

Fig. 2

prevented the drying processors to compete in this trade. The stiff competition forced them to settle for lower quality fish which consequently commanded a lower price in the market. This has led some of the processors to divert to other business such as smoking and pre-cooking[1/] and sometimes transporting fresh fish to sustain their business. A repeat of the earlier survey was carried out in view of these changes. Of the twelve respondents interviewed during the early-part of the project, four had gone out of business temporarily or permanently during the twelve month period, due to financial difficulties.

In our case the investigations were informed by a processor that all his capital was tied up with his buyers. Investment and operating costs collected in the surveys are given in Tables 3-5.

With the fish dryer fish will be dried right after brining, even with bad weather and at night time, instead of being placed in a shed exposed to the environment. The model under consideration has a capacity of 1 000 kg of fresh fish and an average price per unit of P.Ps. 15 000. During the economic life of the dryer, it is estimated to generate a unit income ranging from P.Ps. 2 300 to P.Ps. 3 900 and net profit percentage ranging from 11 to 19%. The cash flow projection for the dryer shows a net cash flow yield ranging from P.Ps. 181 024 to P.Ps. 185 884. After deducting the investment cost, operating cost, and debt services from the total cash inflow, financial rate of return of 39.6% is realized. The recommended term of financing of the dryer is four years. Tables 6 to 8 give details of operating costs, cash flow and an economic analysis.

IDENTIFICATION OF NEW PROJECT SITES

It was decided to install one dryer in Bo, Tiglawigan, Cadiz in Negros Island and another in Estancia near Roxas City in Panay Island, both in the Visayas. Because of the weather condition in this part of the country, the processors foresee derived benefits from artificial drying and are thus eager to try it. Here, the process of drying normally takes 2 to 3 days under normal conditions. The dried fish products are packed in wooden crates and are shipped to Manila for marketing. The total cost of transport and handling from the time fish are processed and are finally marketed to Manila is P.Ps.12.00/box. The processors catch their own fish for processing and there are a few middlemen from Cadiz who do the bulk buying and shipping of the produce, so are assured of ample supply of fresh fish. These processors own fishing boats which can carry an average of 15-20 boxes (40 kg/box).

LOCAL COMMENT AND REACTION

During the period of operation in Mercedes, Camarines Norte, people were aware of the presence of an artificial dryer in their locality. Upon knowledge that the machine was able to dry even during bad weather, many people enquired how the dryer operated. Seeing the product of the dryer, they said that is was comparable to sun dried, in appearance and taste. Others commented that there were added expenses for gasoline or electricity to run the blower. Others who have tried it, said that the result was favourable and they were able to get good returns for the product immediately after drying. There is still some hesitancy but the general feed back from the people was that it is a good substitute to sun drying, especially during bad weather. The general response of people in Mercedes, Camarines Norte, was encouraging. Local processors have approved the site and made inquiries on the principles and operation of the dryers and particularly on the cost. They have been particularly receptive with the set up during bad weather and there were times when they had to line up for their turn in using the dryer. During sunny days, however, processors still prefer to sun dry. It is felt that for them to recognize the potential of the system, the dryer has to be operated on a continuous basis so that processor can get used to it. A scheme for introduction and monitoring of extension activities for the dryer is shown in Figure 3.

1/ Pre-cooked is a process of cooking the fish in brine solution prior to smoking. In Mercedes, people transport fish in pre-cooked condition and sell it to the smoking processors in places in Southern Bicol like Albay and Sorsogon. Pre-cooked fish in brine is very saleable in these areas and a bigger profit is obtained from this operation due to lower fuel and labour costs.

Table 3

Average capital investment of dried fish processors in Mercedes, Camarines Norte

Item	Unit Cost (P.Ps.)	Useful life (years)	Small Scale		Medium Scale		Large Scale	
			Quantity	Cost (P.Ps.)	Quantity	Cost (P.Ps.)	Quantity	Cost (P.Ps.)
Land	$15/m^2$	-	$600\ m^2$	9 000	$1\ 000\ m^2$	15 000	$1\ 200\ m^2$	16 800
Shed	$23.3/m^2$	10	$100\ m^2$	2 330	$600\ m^2$	14 000	$600\ m^2$	14 000
Drying trays	4	1	200	800	500	2 000	1 500	6 000
Bamboo racks	2	1	10	20	50	100	100	200
Steel vats	40	1	10	400	10	400	10	400
Rattan baskets	12	1	20	240	50	600	100	1 200
Knives	12	1	6	72	6	72	6	72
Fish scaler	5	1	6	30	6	30	6	30
Brushes	5	1	6	30	6	30	6	30
Weighing scale	300	5	1	300	1	300	1	300
Brining tank	400	10	1	400	3	1 200	5	2 000
Washing tank	400	10	1	400	1	400	1	400
Miscellaneous				200		300		400
				14 192		20 932		41 832

Approx. US$ 1 = P.Ps. 9

Table 4

Daily operating cost/kg fish of different processors in Mercedes, Camarines Norte

	Small Scale			Medium Scale			Large Scale		
	High	Low	Average	High	Low	Average	High	Low	Average
Fresh fish handled (kg)	500	50	275	1 250	50	650	3 750	50	2 500
Direct Cost (P.Ps.)									
Salt (P.Ps. 30/kg fresh fish)	150.00	15.00	82.50	375.00	15.00	351.00	1 025.00	15.00	750.00
Labor									
Dried whole	20.50	6.00	16.70	53.00	16.00	41.00	119.00	32.00	94.00
Split	132.00	-	78.00	328.00	-	184.00	944.00	-	644.00
Water	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Indirect Cost (P.Ps.)									
Depreciation	14.74	1.88	8.31	36.39	1.89	19.49	72.24	1.36	48.31
Interest on investment	1.44	0.16	0.81	3.55	0.18	1.85	7.06	0.23	4.72
Repair and maintenance	1.80	0.11	0.60	3.97	0.14	2.06	5.11	0.07	3.42
Total Operating Cost (P.Ps.)									
Unsalted whole	38.48	9.15	27.42	97.91	19.21	65.41	204.41	34.66	151.45
Salted whole	128.48	18.15	76.92	322.91	28.21	182.41	879.41	43.66	601.45
Split	239.98	-	138.22	599.91	-	325.41	1 704.41	-	1 151.45
Operating Cost/kg fresh fish (P.Ps.)									
Unsalted whole	0.08	0.18	0.10	0.08	0.38	0.10	0.05	0.69	0.06
Salted whole	0.26	0.36	0.28	0.28	0.56	0.28	0.23	0.87	0.24
Split	0.48	-	0.50	0.46	-	0.50	0.45	-	0.46
Operating Cost/kg dried fish (P.Ps.)									
Unsalted whole	0.24	0.54	0.30	0.24	1.14	0.30	0.15	2.07	0.18
Salted whole	0.78	1.08	0.84	0.28	1.68	0.84	0.69	2.61	0.72
Split	1.44	-	1.50	1.38	-	1.50	1.35	-	1.38

Table 5

Labor cost of different fish processors at different levels of operation

	Small Scale			Medium Scale			Large Scale		
	High	Low	Average	High	Low	Average	High	Low	Average
Quantity handled (kg)	500	50	275	1 250	50	650	3 750	50	2 500
Number of labourers									
Hired									
For washing, salting, etc.									
contractual	2	-	1	4	-	2	6	-	3
permanent	-	-	-	1	1	1	2	2	2
For splitting and eviscerating									
contractual	2	-	1	3	-	2	5	-	3
Operator/Family	2	1	2	2	-	2	2	-	2
Labour Cost (P.Ps.)									
Hired									
For washing, salting, etc.									
contractual	8.50	-	4.70	25.00	-	13.00	75.00	-	50.00
permanent	-	-	-	6.00	6.00	6.00	12.00	12.00	12.00
For splitting fish									
contractual	150.00	-	66.00	300.00	-	156.00	900.00	-	600.00
Operator/Family	12.00	6.00	12.00	12.00	-	12.00	12.00	-	12.00
Added Cost									
Board and lodging of permanent employees	-	-	-	10.00	10.00	10.00	20.00	20.00	20.00
Total Labour Cost (P.Ps.)									
Whole fish	20.05	-	16.70	53.00	16.00	41.00	119.00	32.00	94.00
Split fish	132.00	6.00	78.00	328.00	-	184.00	944.00	-	644.00
Labour Cost/kg fresh (P.Ps.)									
Whole fish	0.04	0.12	0.06	0.04	0.32	0.06	0.03	0.64	0.04
Split fish	0.26	-	0.28	0.36					

Table 6

Comparative breakdown of operationing cost of artificial drying and sun drying

	Sun drying	Artificial Drying 1 000 kg fresh weight 500 kg dried weight (P.Ps.)	500 250 (P.Ps.)	250 125 (P.Ps.)
Handling[a/]	1.00/50 kg fresh fish	20.00	10.00	5.00
Brining and washing[b/]	1.00/50 kg fresh fish	25.50	17.50	8.50
Laying out of fish[c/]	3.30/50 kg fresh fish	16.70	8.35	4.20
Packaging[d/]	6.00/50 kg dried fish	60.00	30.00	12.00
Fuel cost				
Electricity[e/]	-	44.40	25.00	18.50
Ricehull[f/]	-	20.00	20.00	20.00
Service fee[g/]	-	53.60	53.60	53.60
Drying cost/kg dried product	0.24/kg dried product	0.40	0.55	0.90

a/ Handling cost is P.Ps. 1.00/50 kg container
b/ Brining and washing at P.Ps. 8.50/day/person
c/ Laying out is at P.Ps. 0.10/tray at 33 trays/50 kg fresh fish
d/ Packaging material at P.Ps. 6.00/50 kg dried product
e/ Electricity bill at P.Ps. 1.85/kWh
f/ Ricehull was computed per jeep load at P.Ps. 20.00
g/ Service fee for the use of dryer is at P.Ps. 53.60 per operation regardless of the quantity of loading

Table 7

Cash flow for fish dryer[a/]
(in P.Ps.)

	Before adaptation	After adaptation project years 1	2	3	4	5
CASH FLOW						
Gross sales[b/]	420 000	420 000	420 000	420 000	420 000	420 000
Custom service[c/]	-	21 000	21 000	21 000	21 000	21 000
Total gross income (1)	420 000	441 000	441 000	441 000	441 000	441 000
Cash from previous project[d/]	-	1 500	-	-	-	-
Loan: 90% of investment cost[e/]	-	13 500	-	-	-	-
Total inflow (2)	420 000	456 000	441 000	441 000	441 000	441 000
CASH OUTFLOW						
Production cost						
Fish	224 000	224 000	224 000	224 000	224 000	224 000
Salt	19 600	19 600	19 600	19 600	19 600	19 600
Sub-total	243 600	243 600	243 600	243 600	243 600	243 000
Cost of operation						
Wages[f/]	7 680	5 280	5 280	5 280	5 280	5 280
Fuel[g/]	-	2 486	2 486	2 486	2 486	2 486
Repair[h/]	-	1 500	1 500	1 500	1 500	1 500
Insurance[i/]	-	300	300	300	300	300
Taxes[i/]	-	630	630	630	630	630
Transportation expenses[j/]	1 120	1 120	1 120	1 120	1 120	1 120
Contingency[k/]	200	200	200	200	200	200
Sub-total	9 000	11 516	11 516	11 516	11 516	11 516
Total operating cost	252 600	255 116	255 116	255 116	255 116	255 116
Investment cost (4)	-	15 000	-	-	-	-
Debt service						
Loan amortization	-	4 500	4 500	4 500	4 500	4 500
Service fee	-	360	270	180	90	-
Total outflow (5)	252 600	274 976	259 886	259 796	259 706	255 116

(continued)

Table 7 (continued)

	Before adaptation	After adaptation project years 1	2	3	4	5
NET CASH FLOW (2) - (5)						
Financial benefits/loss (6)	167 400	181 024	181 114	181 204	181 294	185 884
Incremental gross	-	-	-	-	-	-
Income (7)	7 680	21 000	21 000	21 000	21 000	21 000
Incremental cost (8)	-	5 280	5 280	5 280	5 280	5 280
Net benefits	7 680	15 720	15 720	15 720	15 720	15 720
Financial rate of return 39.6%						

a/ This model is based on one drying unit
b/ Gross income from fish sales is computed using a price of P.Ps. 15.00/kg yield
c/ Fish dryer is assumed to have an annual usage of fifty six (56) days. The owner is assume to process his own fish and to dry fish for other processors at 5% of dried fish output
d/ The beneficiary's contribution is 10% of investment cost
e/ Loan is assumed to be 90% of project cost
f/ Wages for 3 permanent workers at P.Ps. 150.00/month and 3 contract workers at P.Ps. 10/day
g/ Fuel cost is computed at P.Ps. 1.85/kg/kWh
h/ Repair is 10% at the project cost
i/ Insurance 2% of project cost
Taxes P.Ps. 50.00 plus 3% of gross income of dryer
j/ Reckoned at P.Ps. 20.00 per day for 56 days
k/ Reckoned at 3% of cash expenses

Table 8

Economic analysis of fish dryer

	YEAR 1	2	3	4	5
INCREMENTAL BENEFIT	(P.Ps.)	(P.Ps.)	(P.Ps.)	(P.Ps.)	(P.Ps.)
Less avoided loss[a/]	42 000	42 000	42 000	42 000	42 000
Custom service[b/]	21 000	21 000	21 000	21 000	21 000
Total	63 000	63 000	63 000	63 000	63 000
INCREMENTAL COSTS					
Machinery utilization					
Operator's wage[c/]	7 680	7 680	7 680	7 680	7 680
Fuel[d/]	2 486	2 486	2 486	2 486	2 486
Repairs[e/]	1 500	1 500	1 500	1 500	1 500
Insurance[f/]	300	300	300	300	300
Total operating cost	11 964	11 964	11 964	11 964	11 964
Investment cost	15 000	-	-	-	-
Total incremental costs	26 964	11 964	11 964	11 964	11 964
NET ECONOMIC BENEFITS	36 036	51 036	51 036	51 036	51 036
Economic rate of return 57%					

a/ Fish product save is placed at 10% of the annual product using the dryer

b/ The dryer is assumed to have an annual usage of 56 days and carry out custom drying for other processors at 5% of the total quantity dried

c/ Wages for 3 permanent workers at P.Ps. 150 per month and 3 contract workers at P.Ps. 10/day

d/ Less 15% to cover portion represented by taxes and custom duties

e/ Less 10% to cover portion represented by taxes and custom duties

f/ Insurance 2% of acquisition cost tax P.Ps. 50 plus 3% of gross income

SURVEY

↓

ORIENTATION
a) Features
b) Benefits

↓

ACTUAL DEMONSTRATION
a) Operation, control and management
b) Maintenance and repair

↓

FOLLOW-UP WORK

Constant contact and visit to the Processor's site to check and encourage the continuity of operation of the dryer	Constant contact and visits to the local BFAR office to check the daily activities of the dryer up-dating the technical know-how of the drying community

Figure 3 Procedures taken in the extension of the artificial drying technology

LOW COST, AGRO-WASTE FISH DRIER DEVELOPMENT
(Temperature profiles of different types of fish driers)

by

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ABSTRACT

A low cost, simple fish drier, using coconut husks and rice hulls was developed. During the development, several types of drier designs were tested and compared. Freshly cut slices of green coconut were used to simulate fish in the trials and the performances of the different driers was judged by the temperature profile of the drying chamber. The final modification ended up with a total difference in temperature of 7.6°C over 25 trays.

In a final experiment with fish the temperature difference was 8.6°C and drying time 15-18 hours.

INTRODUCTION

There is an obvious need for an alternative way of drying fish, during the rainy season in the Philippines, when traditional sundrying methods cannot be used. Substantial losses are incurred in particular in remote fishing villages along the coast or on the smaller islands, where ice is scarce and the transportation time long. The aim of the Project was to develop a drier for fishermen or small-scale fish processors in small fishing villages. Most of the smaller fishing villages do not have a continuous electricity supply, if any, and qualified technicians are not readily available if more complicated machinery breaks down. An alternative fish drier should therefore, be simple to operate and maintain and not rely on electricity. The materials used should be available locally and if possible the construction so simple that it could be made in any small town. The fuel should be coconut husks or rice hulls which are cheap and available in most parts of the Philippines.

The first prototype built, combined a small size model of a burner-heat exchanger from a tobacco drier with a traditional vertical drying chamber, covered by a corrugated iron roof. The drier was not very efficient and a grant was obtained from the German Agency for Technical Cooperation (GTZ) for further development. The heating part worked satisfactory and hoods for the drying chamber were developed in several steps. The drying chamber was modified as well but the changes were cumbersome, it was difficult to compare the different trials and none of the modifications worked out satisfactorily. The first drier was abandoned and a new model was constructed that could simulate several types of driers, and each trial could be easily compared with previous ones.

CHARACTERISTICS

Type	:	Vertical tray drier
Fuel	:	Coconut husks, firewood or rice hulls
Air exchange	:	Natural convection aided by a wind driven ventilator or a chimney with a freely turning top
Capacity	:	70 kg to 140 kg of fish, depending on size

DESCRIPTION

Combustion Chamber

The combustion chamber was housed in the base made of 10 cm thick concrete hollow-blocks. Inside dimension 120 x 120 x 90 cm. The firing chamber for coconut husk or firewood was made of soft steel tube, thickness 4 mm, diameter 28 cm, 125 cm long and closed at one end. The firing was done from the open end which started 5 cm outside the concrete wall.

1/ Consultant German Agency for Technical Cooperation (GTZ)

The main body of the firing tube was a part of the heat-exchanger, and branched into two smaller tubes (heat-exchanger wings), that turned back, met and led to an outside exhaust tube just above the open end of the firing chamber (Figure 4). The heat exchanger was made of galvanized iron sheets and could be disassembled for cleaning purposes.

A heat guard of galvanized iron 35 x 120 cm^2, with 2.5 cm holes was placed in the firing end of the chamber to reduce the strong heat radiated from the firing tube and the inclined heat exchanger wings.

There were a total of ten, 10 x 18 cm, air vents around the bottom of the concrete housing of the combustion chamber. Three vents on each of the sides and two each in front and back. Sliding covers were provided for easy opening and closing of the vents. See Figures 1 and 2.

In cases where rice hulls were desired as fuel, a rice hull burner could be connected directly to the firing chamber used for coconut husks. The incinerator was modified from existing concrete rice hull burners in the Philippines. It was made of asbestos sheets on a steel frame for easy adjustment and changes. See Figures 3 and 4. It was operated in the following way. Small wood chips were used as primer and when burning the firing door was closed and the rice hulls poured into the rice hull container which fed continuously through the big opening in the side at the bottom of the container and burned on the grill. The air was sucked in through the openings in the grill. Fire and heat entered the main chamber of the heat exchanger in the combustion chamber and heated the drying chamber.

DRYING CHAMBER

The drying chamber, 120 x 120 x 240 cm^3 inside dimensions was made of four standard size compressed fiber boards 122 x 240 cm^2, mounted on a wooden frame of 5 x 5 cm^2 timber. The chamber was divided into three parts:a central part 60 x 120 x 240 cm and two side parts 30 x 120 x 240 cm. The central part contained the tray racks. There was a total of 25 trays, size 60 x 120 cm, which were made of 2.5 cm mesh fish net mounted on a wooden frame. The vertical distance between the individual trays could be changed with 1.5 cm per adjustment. Normal tray distance was 7.5 cm. The bottom and top opening of the central part could be open or closed, depending on the type of drier to be simulated. See Figures 5 and 6. A movable innerwall was made in the two side-chambers, so the width between the wall and the trays could be adjusted to 0, 10, 20 and 30 cm. The bottom and top opening for each of the adjustments could likewise be closed.

Two different hoods were used to facilitate faster air movements inside the drying chamber. The first was a commercially available wind turbine or wind driven ventilator commonly used in factories and dry food stores in the Philippines. See Figure 1. The ventilator was made of galvanized iron sheets and the crown rotated on a simple ball bearing system. A similar kind of ventilator was used in a solar drier by Lawand, 1981. The second option used was a chimney 25 cm in diameter and 2.5 m high, ending in an inverted L-shaped hood. See Figure 2. The top could rotate freely on the same simple bearing system as above. It would always turn down wind and thereby increase the air exchange inside the drier and the construction prevented rain from entering during heavy showers.

MATERIALS AND METHODS

The different kinds of driers, chimney type, open type, diverted type and diverted type with baffles were tested and evaluated on the temperature distribution of the different trays. The air temperatures of the drier was measured every 15 min with probes, using a Grant temperature recorder. Three probes were placed in the sides and the center of the bottom tray (No. 1); the temperature was measured in the center of every third tray. The outside temperature as well as the inlet and outlet temperatures of the drying chamber were also recorded. Instead of fish, slices of young (green) coconuts were used, either fresh or soaked in water. The slices served two purposes, they blocked the air movements in the same way as fish and the drying rate resembled very much that of fish. The outside wind velocity was measured as well as the air velocity inside the drier (on the trays and in the sides) at several test sites.

A final test of the drier using fish was carried out after optimizing the temperature characteristics.

FIGURE 1. First prototype drier with windturbine/ ventilator

FIGURE 2. The new modified fish drier behind the first prototype with the inverted L-shaped hood

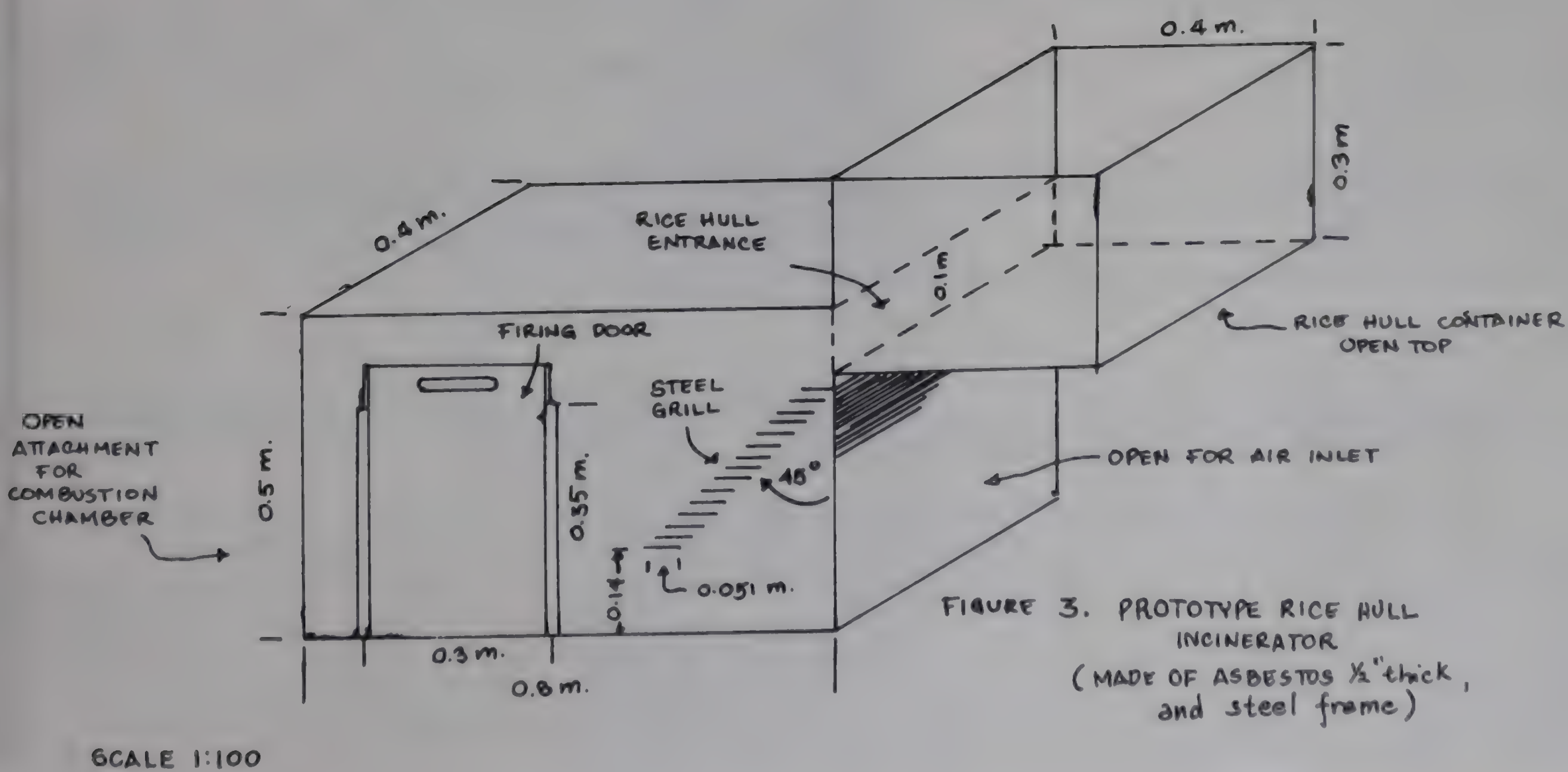

FIGURE 3. PROTOTYPE RICE HULL INCINERATOR (MADE OF ASBESTOS ½" thick, and steel frame)

Seventy kilograms of roundscad was split, cleaned, salted in brine and arranged on the drying trays.

A total of 32 temperature probes was used with 5 probes placed in each corner and in the center of tray 1, 3 probes placed on every third tray:one to measure the temperature in the center of the tray and the two others to check the side temperatures, the incoming and outgoing temperature for the tray. The remaining three probes were used for the outside temperature and the temperature of the air entering and leaving the drying chamber. The temperature was recorded every 15 min, and the air velocity was measured every hour.

The hood with the chimney and freely turning top was used in most of the experiments. The burner for coconut husk was used in the first half of the trials and the rice hulls burner in the second half.

RESULTS AND DISCUSSION

In a preliminary experiment carried out on an Afos kiln the following corresponding temperatures and drying times were found for split roundscad (Milla, 1982).

Temperature	40	50	60	70	^{o}C
Drying time	14	8	6.3	5	hours

Average air velocity	0.9 m/sec
Final moisture content	30-33%

Sensory evaluation, odour, flavour and texture showed that better quality was obtained at drying temperatures of 50°C and 60°C. Even though 50°C-60°C are far higher than the temperature normally recommended for drying of fish, it was decided to use 55°C-60°C as the optimum drying temperature range. In order to standardize the trials, this temperature range was used either as the average temperature on the bottom tray or as the inlet temperature of the drying chamber, depending on type of drier tested. A total of 46 tests were carried out on the different types of driers, but only the main results are discussed.

CHIMNEY TYPE

Open at top and bottom in the center of the drying chamber equal tray distance 7.5 cm, no wall clearance. See Figure 5 open type system, 0 cm clearance.

The heat passed up through the trays and temperature distribution showed a general decrease from tray 1 (bottom tray) to tray 25 (the top tray). See Figure 9. From tray 1 to 10 the decrease was approximately 1°C per tray and from 16 to 25 the drop was 0.3°C per tray. Average temperature was 51.0°C for tray 1 and 34.3°C for tray 25.

No air velocity could be measured on trays above number 10 and only very small values on the lower trays.

When a heat guard with holes was used between the heat exchanger and tray 1 the average temperatures were 52.4°C for tray 1 and 39.6°C for tray 25 and the difference was reduced to 12.8°C. See Figure 9. The air velocity was reduced even more. No further improvement in temperature difference could be obtained.

OPEN TYPE

Open at top and bottom of the drying chamber, central as well as side compartments, equal tray distance, 7.5 cm varying wall clearance. See Figure 5.

The heat passed through the trays and up through the side openings. The temperature distribution was different from the chimney type. See Figure 10. The temperature decreased from tray 1 to tray 8-10 and then increased again up to tray 25. The pattern was the same for wall clearance of 10, 20 and 30 cm. Tray 1 had the highest temperature and tray 4 or 25 the second highest. The temperature difference in the middle section, tray 7 up to tray 19, was less than 3°C for all three clearances, but the temperature was low, between 34°C and 41°C. Increasing the temperature in the combustion chamber had very little effect on the temperature in the middle section.

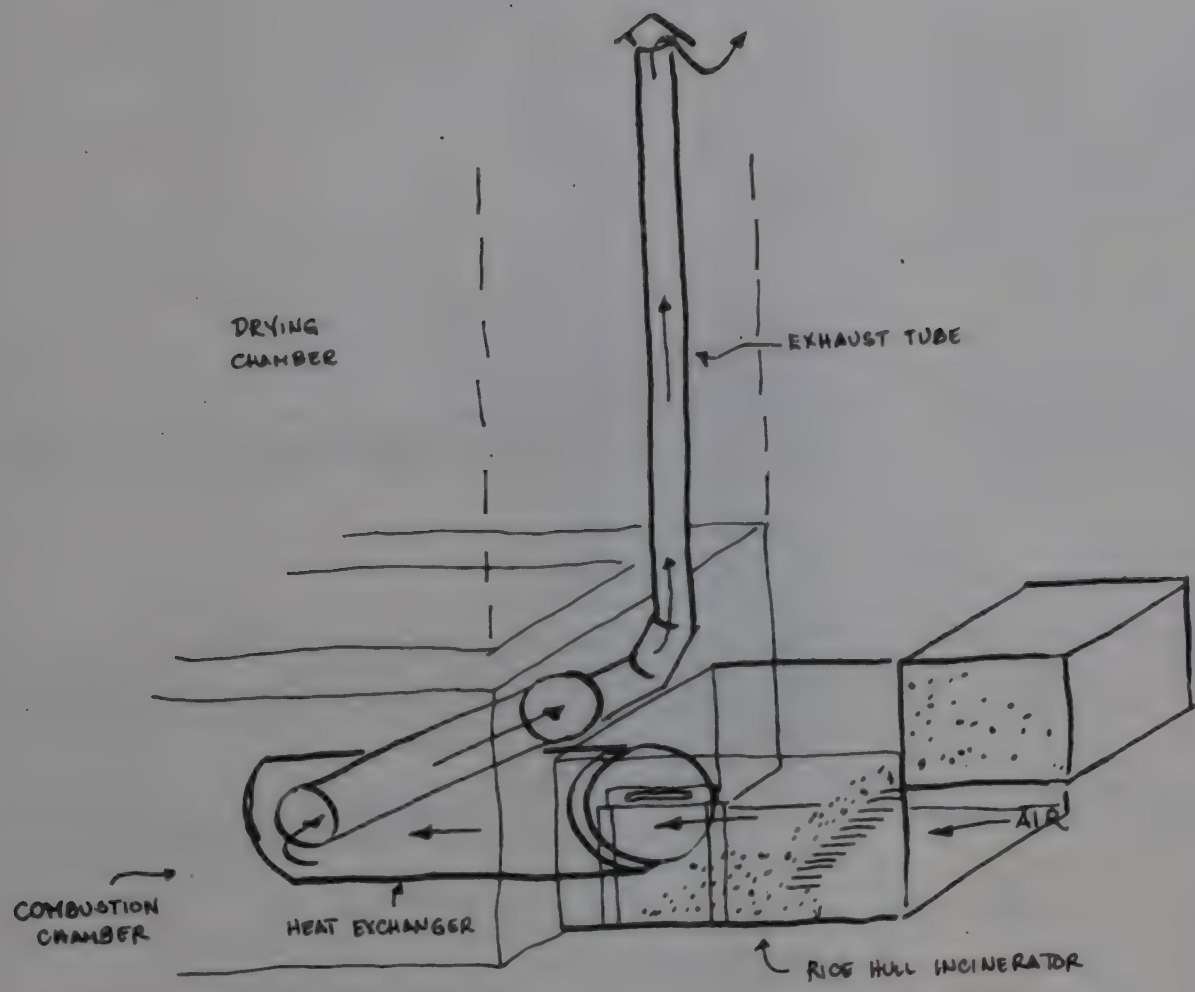

FIGURE 4. HEAT EXCHANGER - RICE HULL INCINERATOR CONNECTION

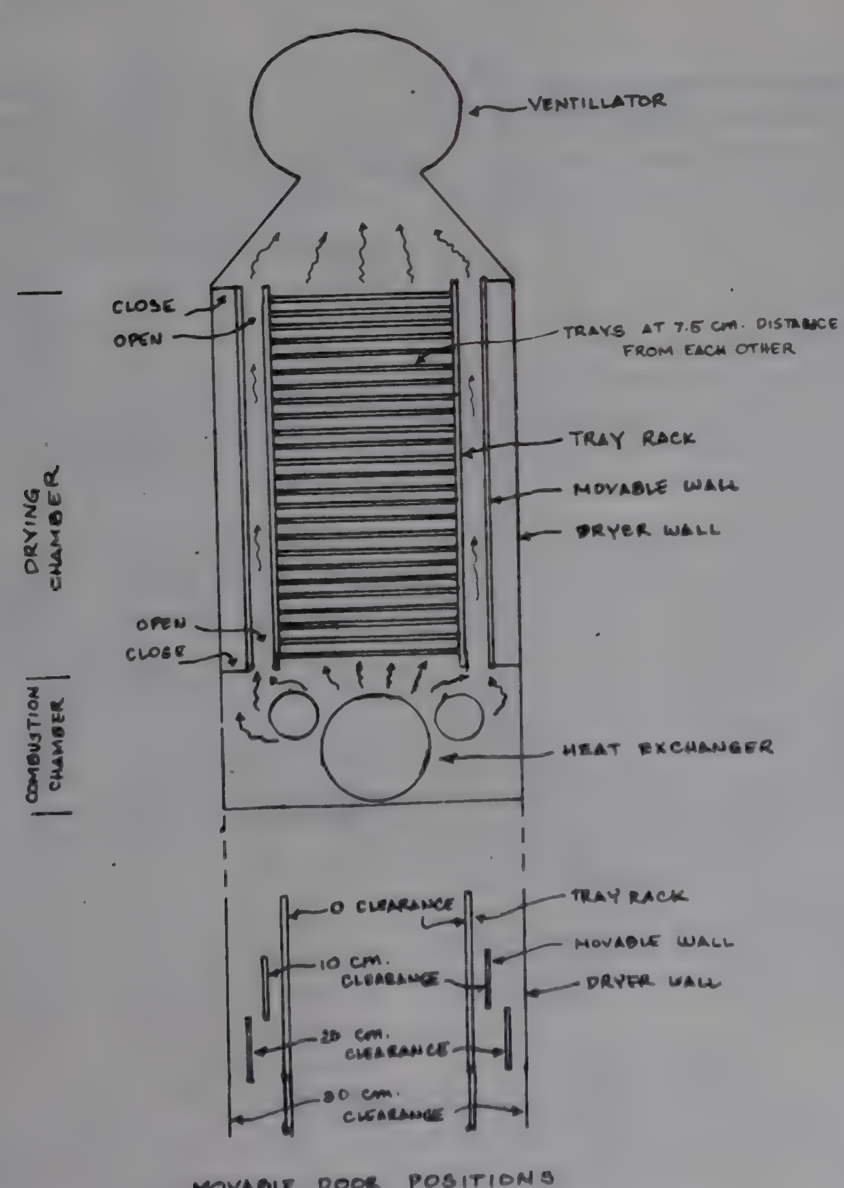

FIGURE 5. OPEN TYPE SYSTEM

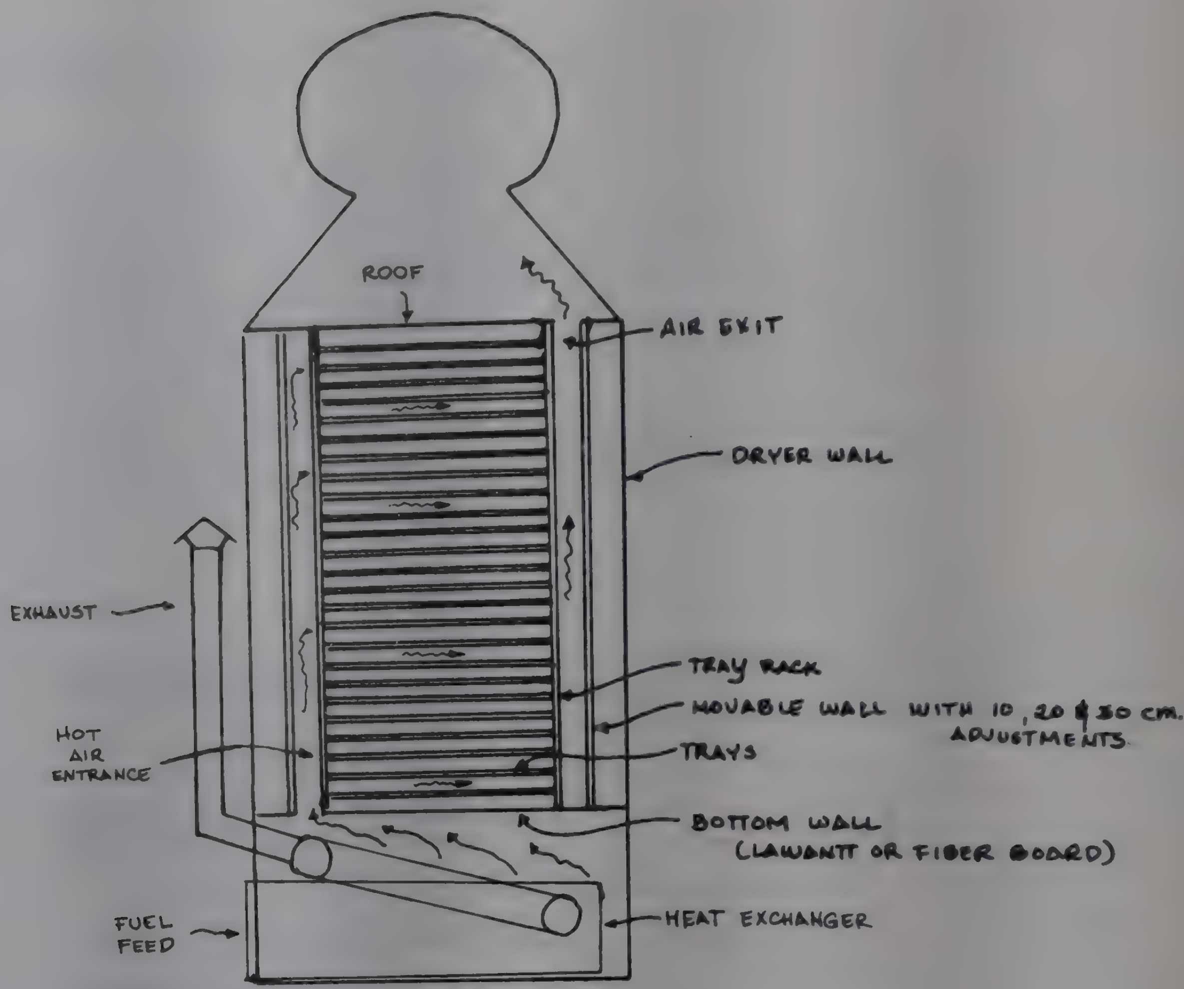

FIGURE 6. DIVERTED SYSTEM

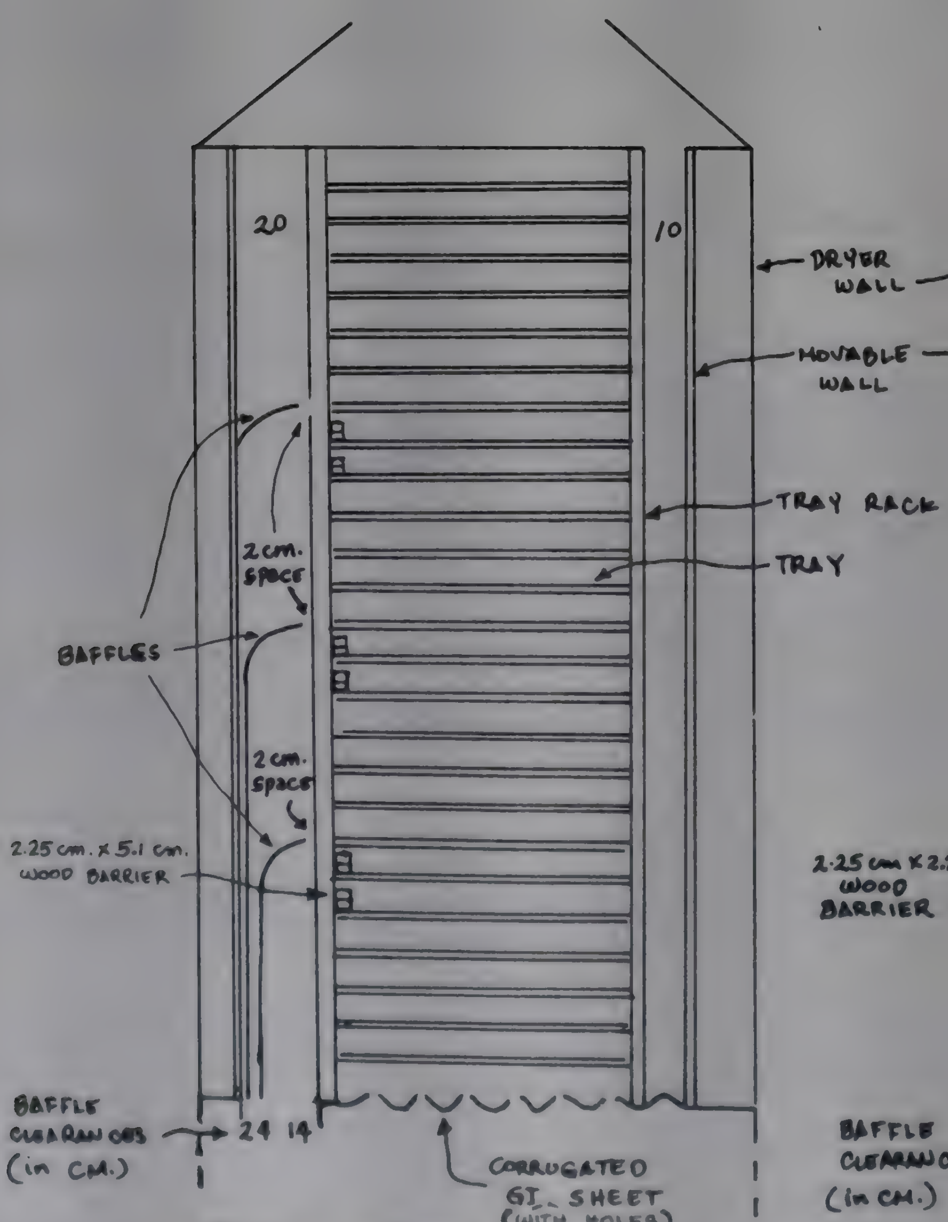

FIGURE 7. WITHOUT WOODRACK

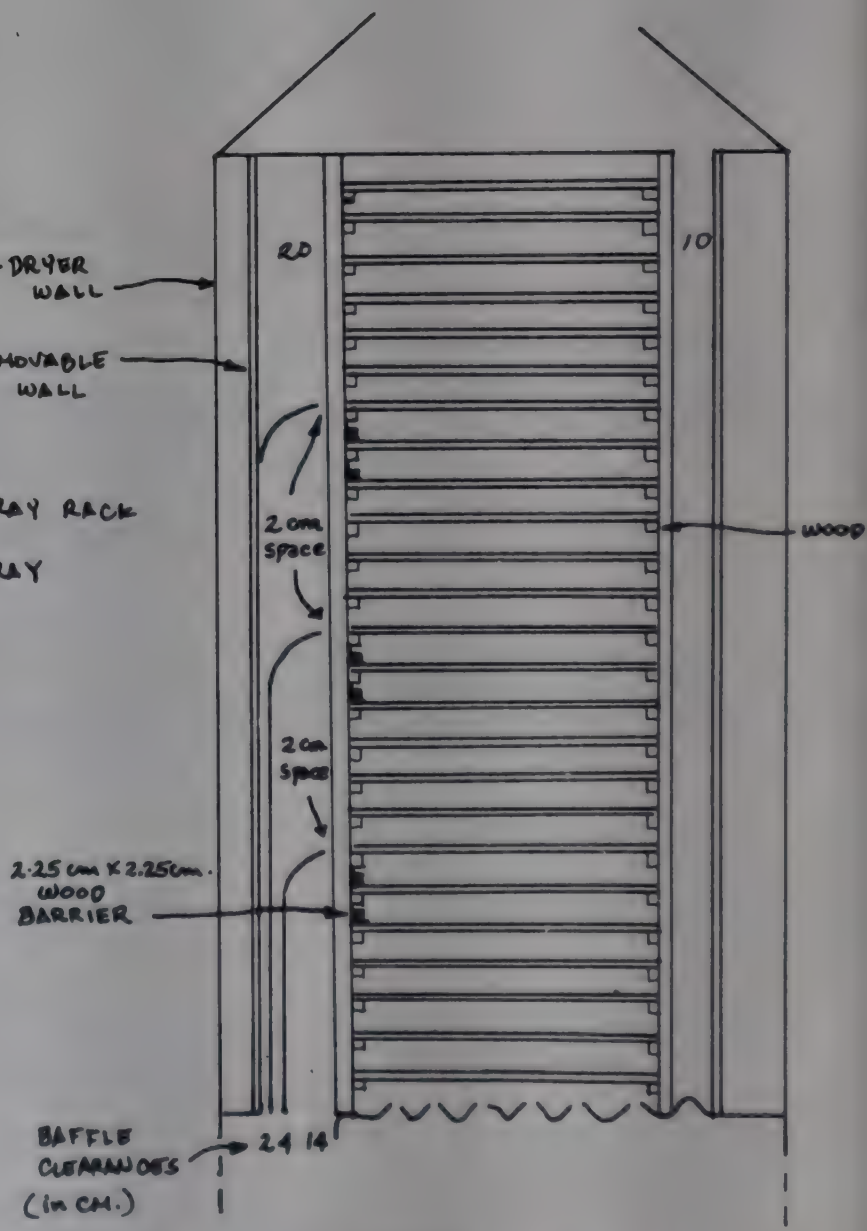

FIGURE 8. WITH WOOD RACK

DIVERTED DOUBLE BAFFLE SYSTEM
(2414 BAFFLE CLEARANCE)

Average temperature ^{o}C

Clearance cm	10	20	30
tray 1	57.4	49.3	55.4
tray 10	37.0	34.5	37.4
difference in temp.	20.4	14.8	18.0

The smaller difference for a wall clearing of 20 cm is caused by a generally lower temperature on tray 1. The air velocity was even lower as compared to the chimney type, as the air mainly passes up through the sides. A lot of heat was lost in the side openings as well.

DIVERTED TYPE

The hot air was guided into one of the side openings at the bottom and was forced to pass over the trays in order to escape through the opening at the top of the other side. Equal tray distance, 7.5 cm, varying wall distance. See Figure 6.

The temperature profile (Figure 11) showed a decrease in temperature from tray 1 to tray 4 and from here a steady increase up to tray 25. The temperature of tray 1 was close to that of tray 19.

Average temperature ^{o}C

Clearance cm	30	20	10
tray 4	35.4	36.4	38.0
tray 25	41.6	51.6	57.5
difference in temp.	6.2	15.2	19.5

For the three wall clearances the 10 cm showed a wide temperature difference (19.5^{o}C), the 30 cm showed a very low temperature difference (6.2^{o}C) but on rather lower temperatures since a lot of heat was lost due to the wide opening. The 20 cm had a difference of 15.2^{o}C, close to the 10 cm clearance, but the incoming temperature was also 10^{o}C lower than for 10, and 3^{o} higher than 30 cm.

DIVERTED TYPE MODIFICATIONS

A total of six combinations of tray spacing were tested. All of them basically increasing the spacing at the bottom and decreasing it at the top, where the temperatures were too low and too high respectively.

The results showed almost the same distribution pattern as with constant tray spacing. However, they also showed that reducing the distance between trays lowered the temperature but increasing the distance between trays did not increase the temperature.

In order to improve the temperature distribution the incoming hot air was divided into two streams by a baffle made of galvanized iron sheets and guided to the lower and higher half of the trays respectively. The wall distance was kept at 20 cm in the inlet side and adjusted to 20 cm and 10 cm respectively on the outlet side. The results showed that the temperature distribution was better for the 20/20 combination but at much lower temperatures than the 20/10 combination so the latter was preferred.

As the temperature distribution with one baffle was not satisfactory, two baffles and eventually three were used to guide the hot air into four sections of the chamber. See Figure 7, but without the wooden barriers.

The combination of two baffles with openings of 6, 6, 8; 4, 6, 10 and 2, 4, 14 cm respectively and a third baffle dividing the top half of the drying chamber gave a temperature distribution as shown in Figure 12. The 6, 6, 8 cm combination gave a picture very

similar to that with no baffles, temperature difference 21.8°C. The 4, 6, 10 combination changed the pattern, improved the level but the difference in temperature decreased only to 17°C. The combination of 2, 4, 14 cm, the most promising, increased the temperature level further and reduced the difference to 13°C. The same combination 2, 4, 14 cm was used with wooden barriers, Figure 7.

The final combination was as above, including wooden barriers to block part of the heat flow on trays at the upper part of the baffles, 2 cm openings between the tip of baffles and trays and corrugated iron sheet with holes at the bottom below tray 1. Furthermore, the trays were placed on horizontal wood racks. See Figure 8.

The results for the three combinations are shown on Figure 12. The final combination showed a total temperature difference of 7.6°C, but a difference of only 4.3°C from tray 4 up to 22.

As a comparison the mechanical Afos kiln (Torry kiln) has a variation of 4°C.

In the test using 70 kg of roundscad, the last of the above-mentioned drier modifications was used, Figure 8. The overall average temperature for each tray was lowest on tray 1, 47.5°C and increased up to 56.1°C for tray 10. From tray 13 to 25 the average temperature varied between 53.1°C and 55.8°C. Temperature difference 8.6°C. The difference between incoming and outgoing tray temperature varied from 1 to 12°C, with the biggest differences observed at trays where the baffle tips end. The smallest temperature differences were found in the bottom and top area. Average outside air velocity was 0.2-0.4 m/s. Negligible air movement was registered in between trays, however, 0.5 m/sec was observed on the hot air entrance and exits. The drying time was 18 hours although approximately 40% of the fish was dried and removed after 15 hours.

Previous trials showed a drying time on 21-24 hours and it is expected that the present 15-18 hours with practically no wind will be reduced further down with increased air velocity outside.

Problems and Recommendations

From the final trial with coconut husk, Figure 12, the lowest and highest temperature was found at the bottom and top trays. The lower temperature for tray 1 can be increased by making bigger holes in the corrugated iron sheet at the bottom. The temperature on the top tray can be reduced by using a stick of wood as a barrier.

The heat exchanger wings had to be cleaned frequently, as soot partially or fully blocked the bends.

The problem was later solved by extending the exhaust up to the top of the drying chamber and increasing the diameter to that of the heat exchanger wings, 16 cm. The firing chamber may be more effective if the diameter is enlarged.

Of the two types of drier hoods, the wind driven ventilator was generally more effective in increasing the air velocity inside the chamber, but the ventilator did not rotate at low wind velocities. At high wind velocities it rotated too fast, and it was difficult to maintain the drying temperature. The ventilator should therefore be used where moderate wind velocities prevail, as it was inefficient at low and too efficient at high windspeeds.

The hood with chimney and freely turning top worked satisfactorily at all wind velocities, but was less effective at moderate windspeed, compared to the ventilator.

Using the final clearance of 20 cm and 10 cm, in the same housing the size of the trays could be increased to 90 x 120 cm^2, thereby increasing the capacity of the drier 50% without extra cost.

PRICE

The total price of the drier including the rice hull burner but excluding labour cost for carpentry work and concrete work, was P.Ps.3 000-3 500, US$ 350-410. The remaining labour cost would be P.Ps.600 or US$ 70.

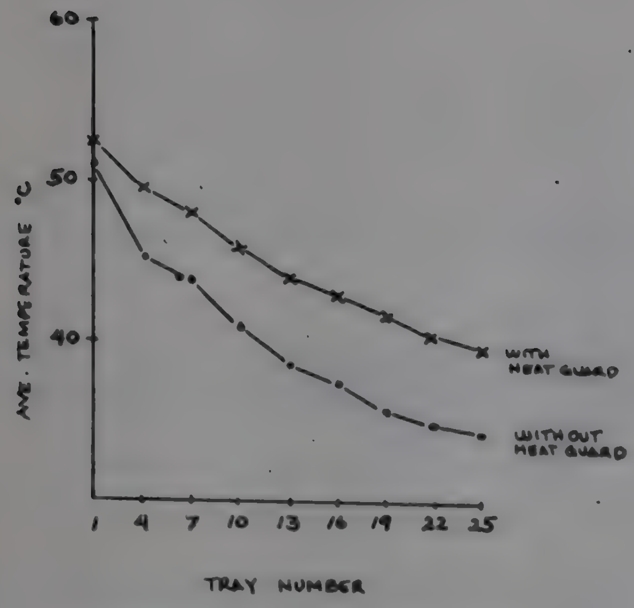

FIGURE 9. CHIMNEY TYPE SYSTEM
OUTSIDE TEMP. - 29 °C

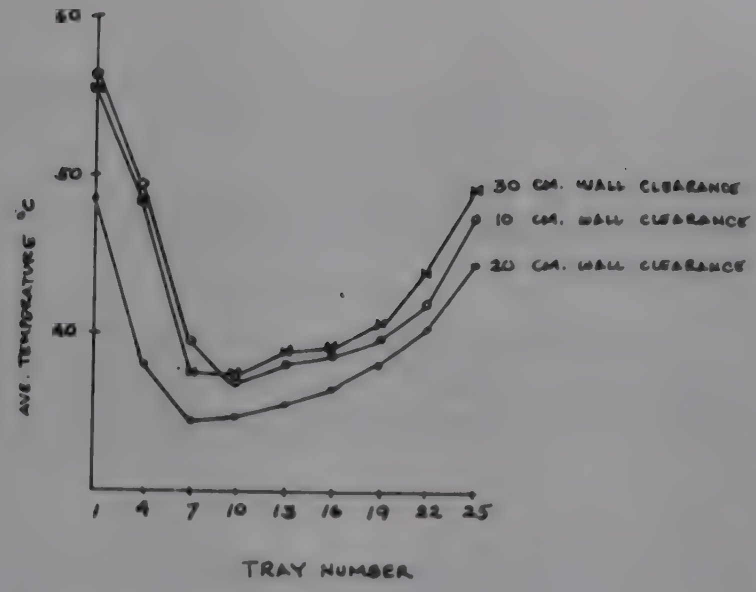

FIGURE 10. OPEN TYPE SYSTEM

AVE. OUTSIDE TEMP. 10 cm. - 32.0 °C
20 cm. - 31.8 °C
30 cm. - 30.9 °C

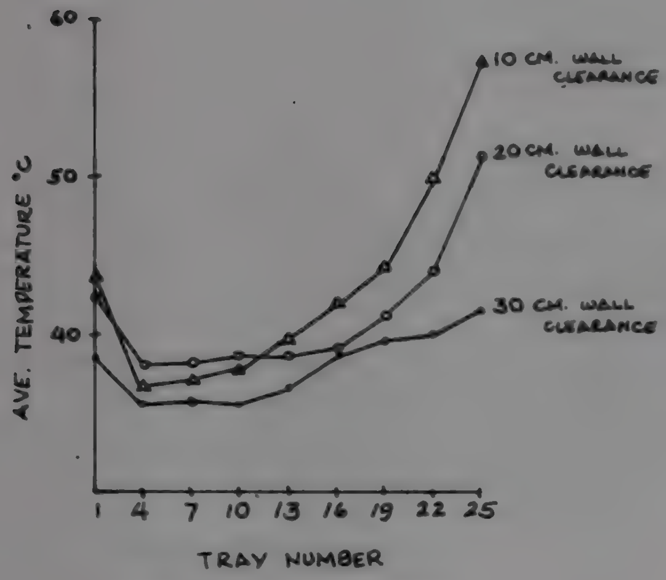

FIGURE 11. DIVERTED SYSTEM

AVE. TEMPERATURE °C	10 CM.	20 CM.	30 CM.
INCOMING	55.3	49.6	56.3
OUTSIDE	30.7	31.8	28.7

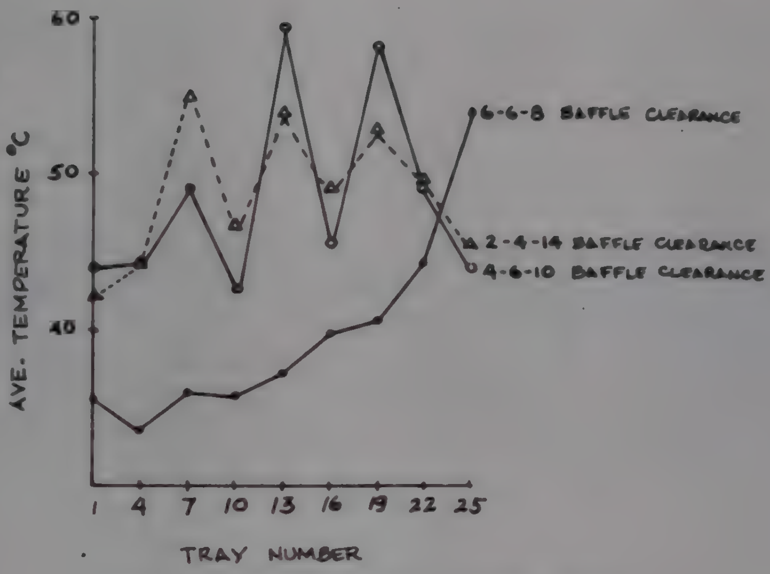

FIGURE 12. DOUBLE BAFFLE DIVERTED SYSTEM

°C AVE. TEMPERATURE	6-6-8	2-4-14	4-6-10
INCOMING	41.2	52.0	59.9
OUTGOING	48.4	48.0	45.4
OUTSIDE	32.1	29.0	32.4

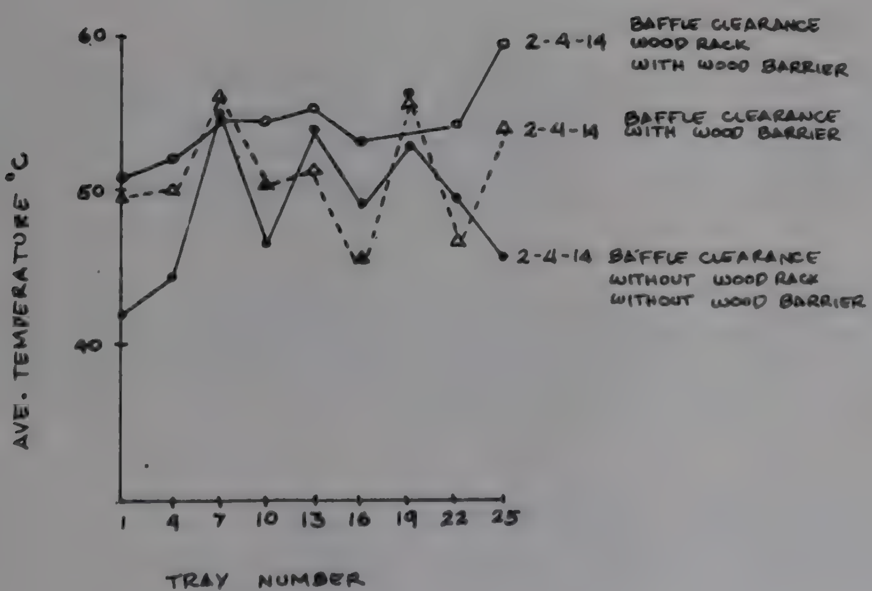

FIGURE 13. DOUBLE BAFFLE DIVERTED SYSTEM.
2-4-14 TRAY RACK MODIFICATIONS

AVE. TEMPERATURE °C	2-4-14	2-4-14 WITH WOOD BARRIER	2-4-14 WITH WOOD BARRIER WITH WOOD RACK
INCOMING	52.0	57.0	57.5
OUTGOING	48.0	48.4	48.4
OUTSIDE	29.0	33.0	31.4

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ACKNOWLEDGMENT

The authors wish to thank Mr Ernesto Airan for his efforts in firing the drier and recording the temperatures.

A NEW SOLAR-AGROWASTE SMOKER-DRIER FOR FISH AND SHELLFISH

by

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ABSTRACT

Four types of solar driers and two agro-waste driers were compared for the drying of round scad, frigate mackerel, mussels and squid. Drying rates, microbiological examination and sensory evaluation gave indications of improved quality from solar and agro-waste driers and showed a need for moisture contents to be 10% or less, with good packaging, to ensure prolonged shelf life.

INTRODUCTION

Trade in Dried/Salted and Smoked Fish

About 61% (2.4 million tons) of dried, salted or smoked fish are produced annually in Asia. China and Japan produce 36% and 34% of the total, followed by Indonesia (15%) and the Philippines (7.2%). In the Philippines, dried fish worth US$ 322 000 (170.5 t) are exported mainly to Japan, USA and Saudi Arabia. Smoked fish (value = US$ 233 000, total = 124.6 t) are exported mainly to England, Hong Kong and USA. Shrimps, abalone, cuttlefish and squid are the main invertebrate export items. Dried shrimps (106.8 t; value at US$ 288 000) are exported mainly to Japan and the USA.

Dried and Smoked Fish Products

In the Philippines, the problem of drying fish during the long rainy season has been felt by fish processors. The quality of products is quite poor and spoilage losses have been estimated to as much as 15-20%. Sun drying of fish is commercially practised in most parts of Asia. For small fish which have a faster drying rate, the problem of fly infestation is not serious, but with thicker and larger fish, the use of solar or augmented fish driers will yield a more hygienic product and increase the rate of drying (Waterman, 1976; Doe, 1977).

Smoking establishments in the various regions of the Philippines require much space and the smoke permeates the whole area used for processing, thus introducing an additional health hazard to workers, and contributing to sources of air pollution. The brine used for smoking is also used for several months or even years, reducing the shelflife of smoked fish to only a few days.

Several solar driers and agro-waste driers were designed and evaluated to help solve current problems in fish drying and smoking. An assessment of post-harvest losses in cured fish (FAO, 1981) showed high levels especially during rainy season in the tropics.

REVIEW OF LITERATURE

The basic principle involved in the drying of food, whether by natural or artificial means, is the reduction of moisture content to such extent that decomposition by both bacterial putrefaction and enzymatic autolysis is stopped or, at least sufficiently inhibited to ensure reasonable keeping quality (Tressler, 1960). Sun drying is one of the conventional methods of fish preservation. It is a process in which removal of moisture is effected by exposure of the product to natural currents of air and humidity which are dependent on the climatic conditions (Jason, 1965). The advantage of this method is that no specialized equipment is necessary, but drying by exposure to wind and weather is a relatively slow process. This results in a great loss through spoilage, lack of uniformity

in the final product and development of undesirable flavours due to exposure to various sources of contamination such as:

(a) airborne dust and wind blown debris like leaves;
(b) insect infestation; and
(c) moulds.

The sun-dried products usually appear discoloured, brittle and mouldy. Thus, a wastage of about 30% of the total foodstuff is incurred.

Solar driers were designed to solve problems involved in the traditional sun-drying method. These can be classified (Anon., 1982) according to the manner in which heat is transferred from solar radiation to the material being dried as follows:

1. The absorption or direct type, where heat from solar radiation is transferred by the direct absorption from solar energy to the material being dried. This is achieved through the use of an enclosure covered with transparent material like plastic or polyethylene sheet.

2. The convection type or indirect type wherein air is heated in a solar collector is conveyed through a heat exchange to a drying chamber.

3. The combined method wherein heat transfer is activated by a combination of direct and indirect methods of heat transfer.

The solar tent-type drier which was designed by (Doe *et al.*, 1977) operates by absorbing solar radiation through a clear polyethylene sheet thus increasing the temperature of the air in the drier. With no wind blowing, a draught is induced within the drier due to the tent acting like a chimney. Moisture removed from the fish during drying is either carried out with the air exhausted through vents at the top of the drier or condenses on the inside surface of the polyethylene. An advantage in allowing condensation, however, enhances the glass-house effect. The effect of wind is to reduce temperature within the drier by increasing the heat losses from the drier through the polyethylene and by increasing the air flow through the vents.

Various tests showed that solar-tent drier reduced fly infestation and drying time. Haque (1982) noted that the solar-tent drier yielded a superior product in a shorter time and made suggestions for improvements. Alternative designs for the driers can be made for places where different local materials are available. Clear or ultraviolet-transparent polythene of a thickness not more than 100 micrometers is reasonably strong and should at least last for one year or drying season. Canvas, wooden boards or any heavy material that can act as an absorber of heat must be air-tight to minimize heat loss in the drier.

In addition to the tent-type drier, different types of solar and augmented driers (Protacio, 1979: Orejana, 1982) were constructed and tested. Comparison between the driers as to cost and efficiency (moisture content of fish vs time in drying) were conducted. Pablo (1978) has also used agro-waste driers for the drying of fruits. The driers operate by the combination of direct and indirect method of heat transfer.

Sison *et al.*, (1981) has done work on the development and evaluation of artificial driers with varying capacity. Some driers are equipped with a furnace and a blower assembly driven by a petrol engine to force hot air to the drying chamber. Some were fueled by rice hulls, LPG or kerosene.

MATERIALS AND METHODS

Construction of Solar Driers and Agro-waste Drier

Four types of solar driers and two agro-waste driers (Figures 1-6) were constructed and evaluated. The solar driers are made of wood and polyethylene sheets with some metal parts used for the agro-waste drier. One of the agro-waste driers is made of angular bars and asbestos walls (Figure 5). The driers is L-shaped and the fuel can be fed directly below the drying trays or into the other chamber for the cold-smoking process.

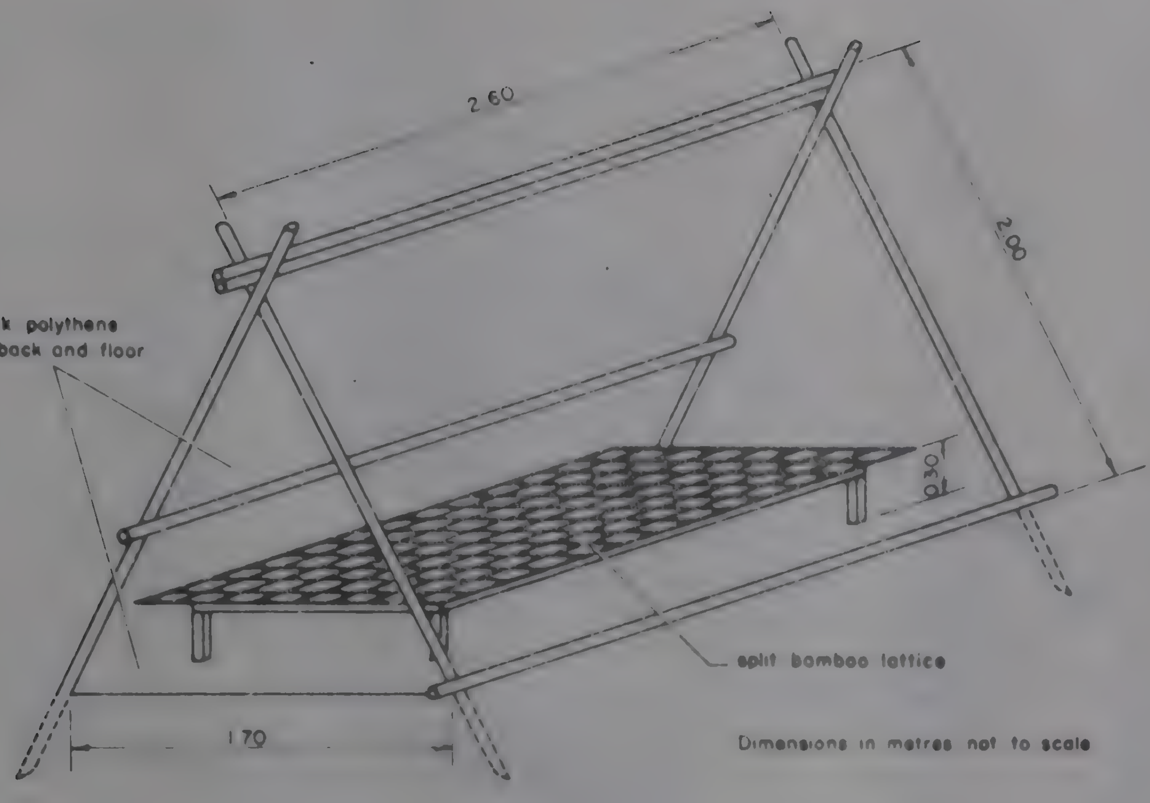


Fig. 1 POLYTHENE TENT DRYER

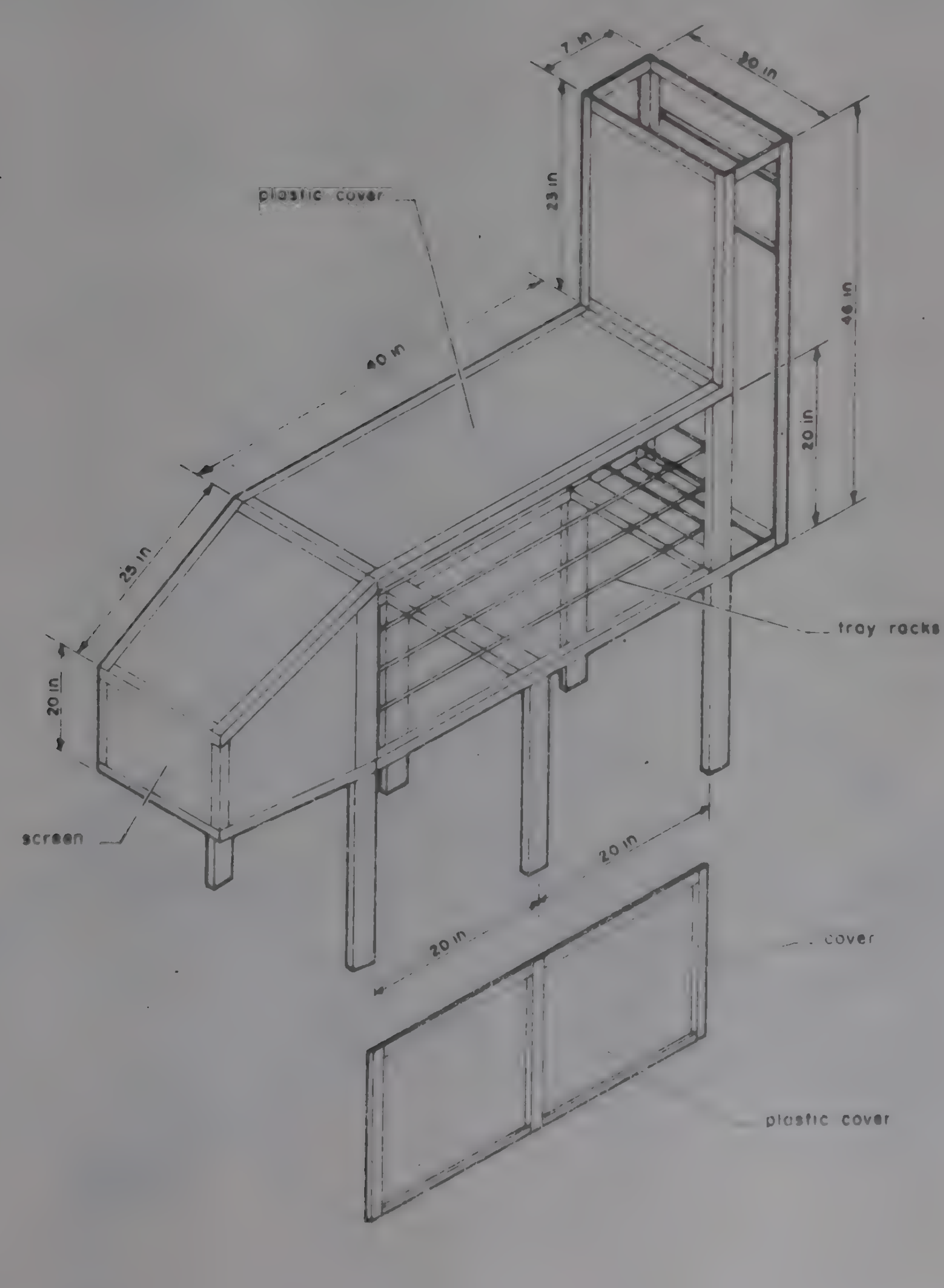


Fig 2 SOLAR DRYER (chair type)

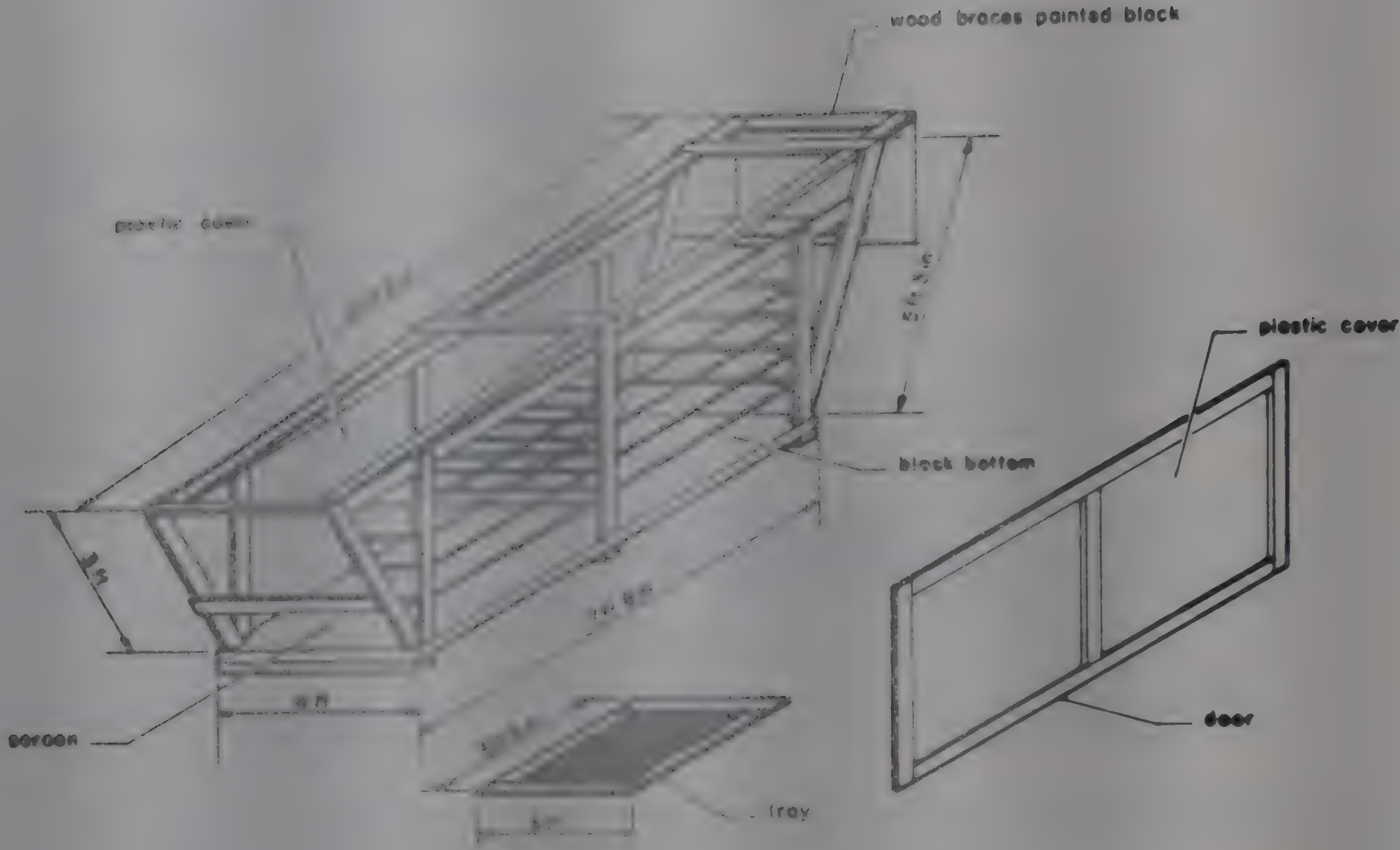
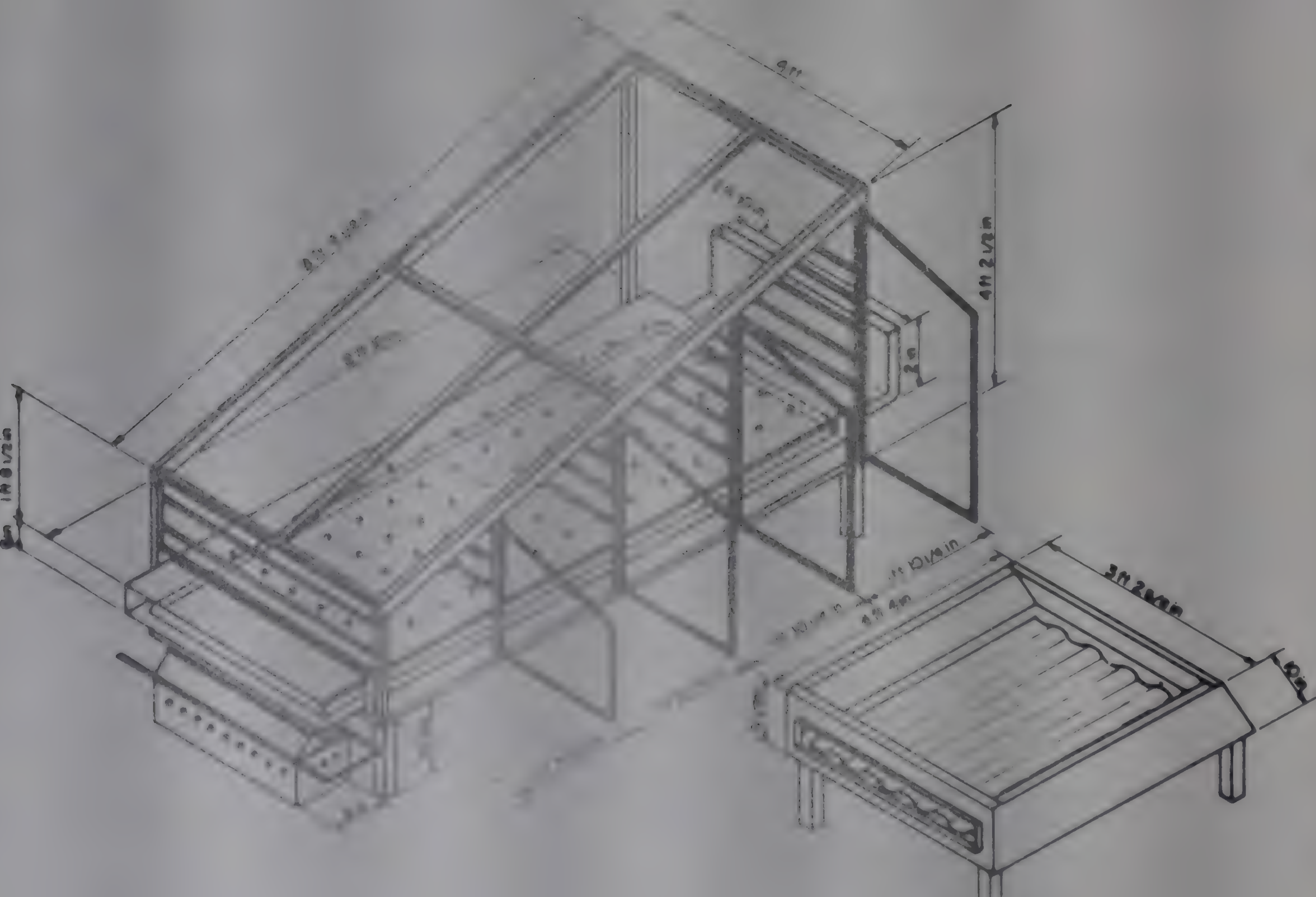


Fig 3 SOLAR DRYER



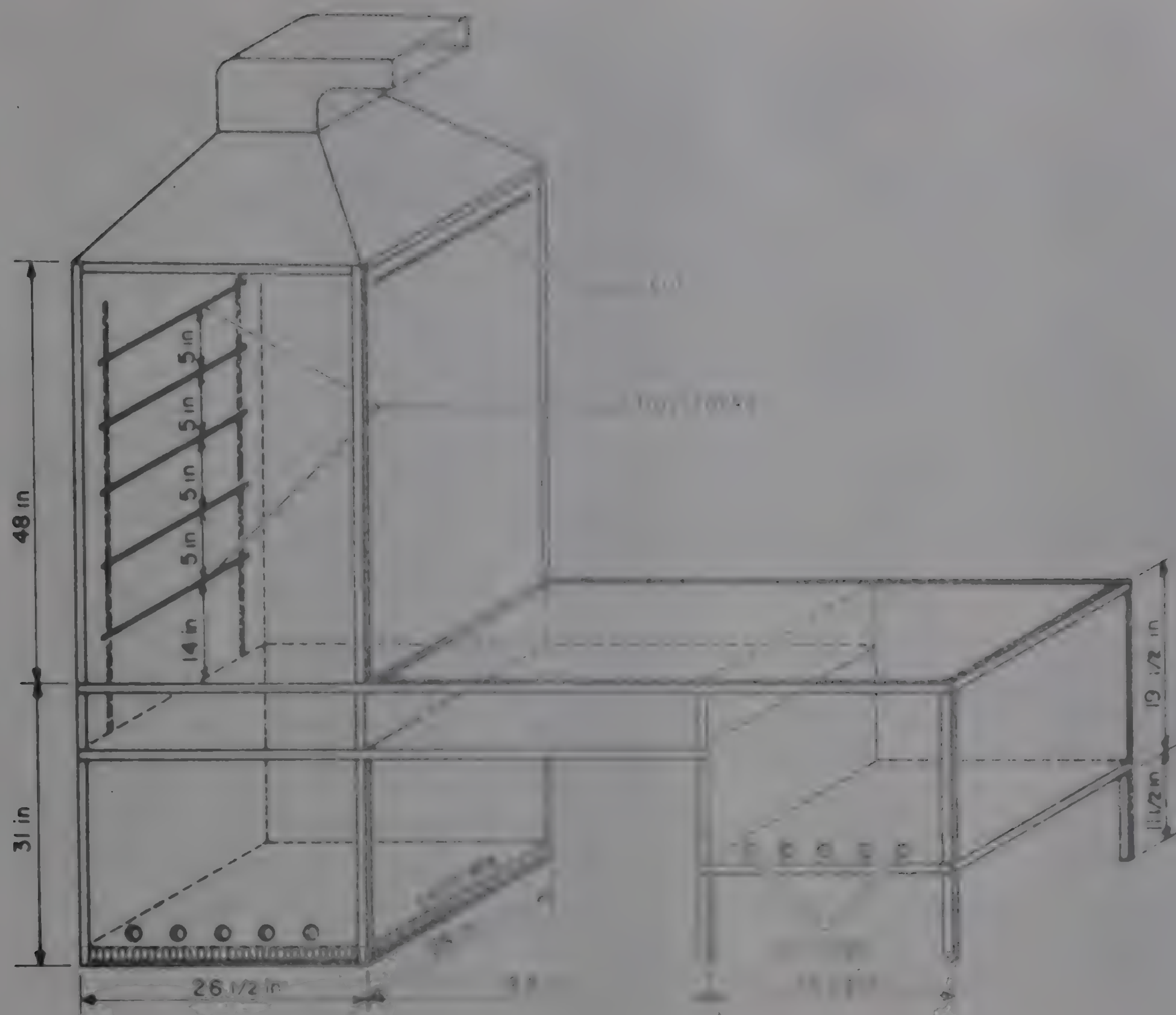


Fig. 5

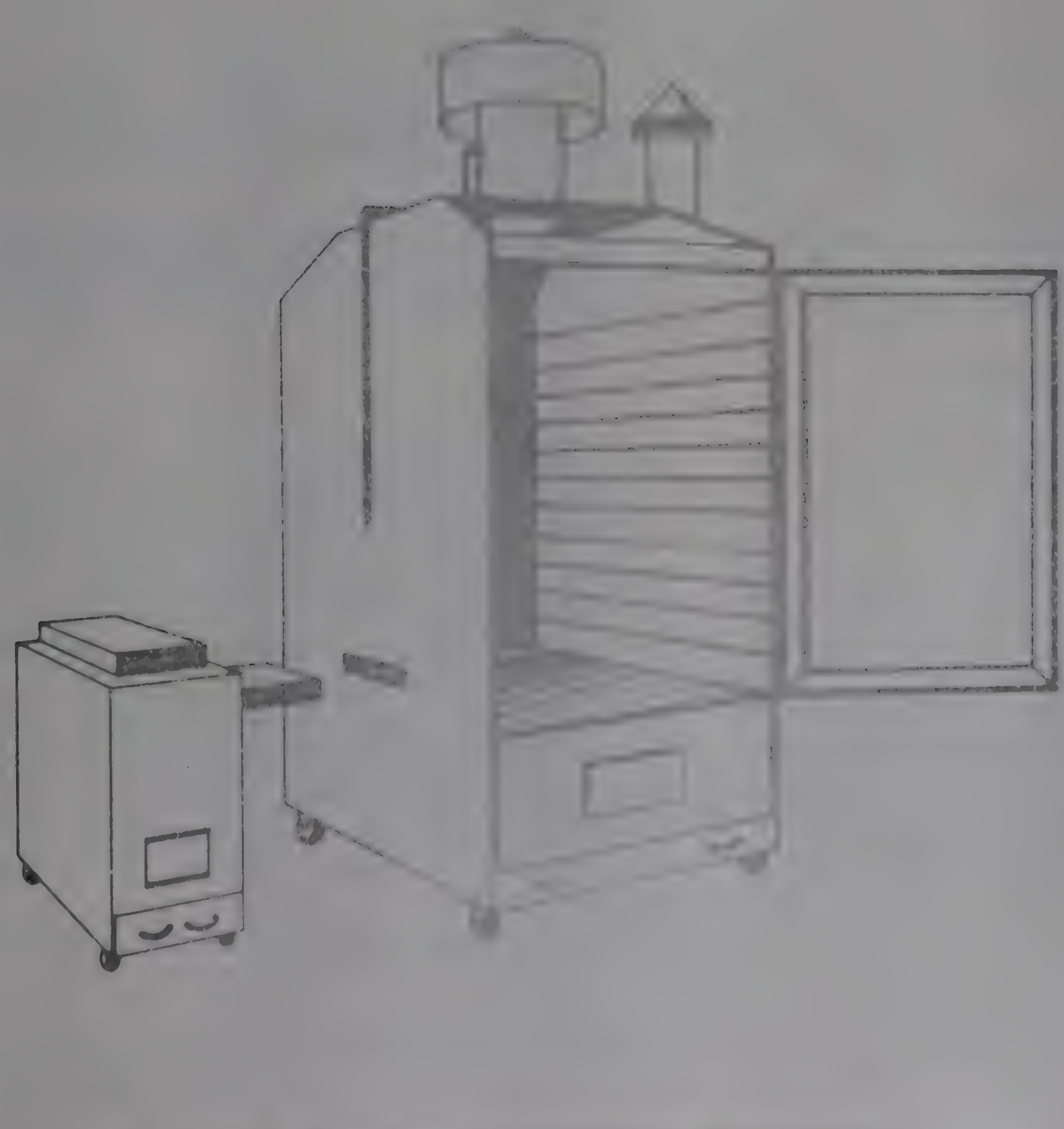


Fig. 6 SOLAR ... /SMOKER

A new solar agro-waste fish drier/smoker was also constructed to improve the drying efficiency of fish and shellfish as well as the quality of smoked and dried fish. The capacity of the drier was also increased to 150 kg in order to increase output per day. The good features of previously constructed driers were combined in the design of the new agro-waste solar multipurpose drier and smoker (SAM type) (Figure 6). The SAM type of drier is essentially an upright rectangular box with its roof tapering down at an angle of 20°. It is made of metal on all sides except for the roof, door and side opposite the door which are made of polyethylene sheet or acrylic cast sheet. In the main chamber, twelve (12) tiers of angular bars were constructed on the side walls, in order to hold twelve (12) pairs of trays which are easily inserted. The trays can be made of wood and fish net or plastic or stainless steel. The door is mounted on the side with two or three hinges, and may be opened outward for easier sliding of shelves and to facilitate cleaning of the interior. The chimney of the roof is also made of metal. The opening is regulated by the damper to regulate the flow of heated air in the chamber. This type of chimney (Figure 6) is suitable for the smoking operation. For drying purposes, another type of chimmey, a rotating circular type of ventilator is recommended.

The furnace is situated below the trays and separated from the upper chamber by corrugated metal. The ash collector below is an additional feature. The small door to the combustion chamber and the chimney with a damper which is attached to the lower part of the furnace help regulate temperature. The whole body is painted black to maximize heat absorption and retention. The roof and the two sides (including door) are made of plastic or acrylic sheet to allow penetration to sunlight into the chamber. A side chamber which serves as a smoke generator may be connected to the side of the drier, if smoking operation is desired (Figure 6). During the rainy season or in inclement weather, the drier can be fed with agro-waste such as firewood, wood shavings, charcoal, rice husks or coconut husks. The drier can also make use of solar energy and the black walls can absorb and retain heat efficiently.

The various types of solar and agro-waste driers were evaluated as to temperature range, capacity, life span and cost. The temperatures obtained were measured using thermocouples and a continuous recording Ellab potentiometer. Wet bulb temperature and air velocity were also determined.

Using various fish and shellfish, the drying rate and the drying curves of the various driers were analysed. Sorption isotherm properties of samples from the driers were compared to the sundried samples by the use of Henderson's plot and Wink's equilibrium method.

Fish and shellfish dried using the various types of driers were analysed for protein content by the Kjeldahl method, lipid content by Soxhlet extraction, ash by the AOAC method and the carbohydrate content by difference. Log yeast and mould counts as well as total plate count and halophile count were also determined.

RESULTS AND DISCUSSION

Table 1 summarizes the temperature range, capacity, life span and cost of different driers. The tent-type, which is the cheapest and the simplest has a temperature range of 37°C to 57°C, an area of 4 m^2 and a life span of one to two years. This can be applicable to the drying of larger fish and shellfish during the dry season where there is adequate sunlight. The chair-type and the boat-type of solar drier increase the capacity of the driers to several layers and occupy less space. The useful life is longer but they are more difficult to construct being made of wood and polyethylene sheets with trays made of metal screens. The soldry (Sta Barbara type) of solar agro-waste drier has been used efficiently for drying of fruits, but has not been extensively tested for drying fish and shellfish. Using the booster, the soldry type can be fed with agro-waste, however, feeding has to be made frequently (every fifteen minutes) and the temperature fluctuates by as much as 10°C before refueling. The L-shaped agro-waste drier (Figure 5) is made of asbestos and has a useful life of around twenty years, but has a relatively low capacity and high cost. It can only make use of agro-waste fuel and cannot utilize solar energy.

Combining the good features of the other types of driers, a design of new solar agro-waste fish drier-smoker (14.3 m^2) was conceived (Figure 6). Based on the performance of of the solar and agro-waste driers, actual experience and the results published in local

Table 1

Summary of temperature range, capacity, life span and cost of different driers

Type of drier	Temperature range (oC) Min	Max	Capacity Area (m^2)	Weight (kg)	Useful life (years)	Estimated cost (P.Ps.) (as of 1981)
1. Solar drier						
a. chair-type	52	62	3.0	15-20	3-5	1 800.00
b. boat type	44	52	3.76	30	3-5	1 850.00
c. soldry	46	55	8.04	60	3-5	6 500.00
d. tent type	37	57	4.0	25	1-2	200.00
2. Agro-waste drier[a/]						
a. L-shaped drier	45	75	1.01	10	15-20	4 500.00
b. soldry	47	80	8.04	60	3-5	6 520.00
3. Solar agro-waste drier/ smoker[b/]	49a	70				
	39b	74.7				
	41c	80.5	14.3		10-15	7 000.00

a/ using charcoal as fuel
b/ using charcoal a, paper b, and coconut husk c, respectively US$ 1 = Approx. P.Ps.9

Orejana, F.M. and M. Embuscado, 1982. Solar and Artificial Methods of Drying. College of Fisheries, UP

Table 2

Sensory evaluation scores of dried roundscad using solar and artificial driers and samples from the market

Type of drier used/source	Odour	Flavour	Texture	General acceptability
1. Solar drier				
1.1 boat type	7.3	7.3	6.9	7.2
1.2 chair type	7.5	6.7	7.2	6.5
1.3 Sta Barbara	7.2	6.5	6.7	6.7
2. Agro-waste drier				
2.1 Sta Barbara	5.9	4.5	4.1	4.5
2.2 L-shaped type	7.1	6.4	6.2	6.7
3. Sun drying	7.3	7.2	7.1	7.1
4. Market samples				
4.1 pasig	7.3	6.0	6.1	6.2
4.2 quinta	7.2	6.5	6.7	6.7
4.3 farmers'	7.5	7.2	7.1	7.1

and foreign literature, the new fish drier was designed to incorporate a good heat retention and distribution, high loading capacity, relatively low-cost and high durability, capacity to utilize both solar and agro-waste sources of energy and a large combustion chamber.

Drying of Roundscad (*Decapterus macrosoma* Bleeker)

The drying curves of roundscad using the boat type and L-shaped agro-waste drier compared to sun drying were determined (Figure 7-8). The initial moisture content (3.18 g water/g solid, dry basis) was reduced to 1.69 using the boat type drier after 12 hours; using the L-shaped drier fed with charcoal, the final moisture content was 1.22 g H_2O/g solid after 10 hours and for sun-drying, a final moisture content of 1.80 g water/g solid, dry basis.

Chemical analysis showed a range of protein from 47-58%, moisture from 27-33.6%, and salt 10.22-12.18%. Sensory scores of dried roundscad using solar and agro-waste driers (Table 2), as well as total plate, yeast and mould and halophile counts compared to market samples were determined (Table 3). Log halophile counts ranged from 4.4-5.19 in the agro-waste drier and 5.82 in the boat-type solar drier compared to 6.4 for sun-dried samples. Market samples showed higher values ranging from 6.35 to 6.9.

Drying of Frigate Mackerel (*Auxis thazard* Lacepede)

The drying rate curve of frigate mackerel (Figure 9) was determined using the solar agro-waste multipurpose drier (SAM drier). The initial moisture content of 2.53 g water/g solid, dry basis was reduced to 0.63 for split mackerel and 0.76 for dried whole mackerel after nine hours drying. Microbiological analysis indicated a log value of 7.05 for total plate count, 6.35 for yeast and mould count and 5.18 for halophile count.

The sorption isotherm curve was divided into three regions (Figure 10) (I, II, III) using the graphical interpolation method and Wink's equilibrium. This determines the specific types of bound water that influence the chemical and physical properties of dried products. Beyond region II, deterioration occurs. Three intersecting lines of Henderson's plot were used to indicate the lower and upper limits of this region. Based on these tests, the dried frigate mackerel has an equilibrium moisture content (EMC) range of 0.08 g H_2O/g solid to 0.144 g water/g solid under Aw (ERH/100) of 0.10-0.46.

Drying of Mussels (*Mytilus smaragdinus*)

Mussels were purchased from Rosario, Cavite boiled, shucked, and then dried using the chair-type, the agro-waste L-shaped drier and by traditional sun drying. The initial moisture content of 2.58 was reduced to 0.32 g H_2O/g solid after 4.0 hours using the chair-type, 0.27 g water/g solid under sun drying and 0.29 g water/g solid using the L-shaped agro-waste drier (Figure 11).

The microbial load of samples dried using the chair-type drier was compared to sun-dried samples. Log values of yeast and mould count, total plate count, and halophile count were 6.29, 7.95, and 4.75 respectively for solar-dried samples while for sun-dried samples, log values were 6.6, 8.76, and 5.064 which are relatively higher than solar-dried samples.

Sorption isotherm studies showed that sun-dried mussels have a moisture range of 0.01 -0.10 g water/g solid with an Aw 0.275-0.49 (ERH/100) while the solar-dried sample had an EMC (equilibrium moisture content) range of 0.105-0.22 g H_2O/g solid, on a dry basis with an Aw of 0.24 -0.51 (Figure 12). These values indicate that the product produced by the chair type is superior to the sun-dried product since the former has a wider range of region II based on the results obtained using BET and Henderson's plot. Thus, the storage conditions of the product should remain stable for a longer time if kept within the limits of Region II.

The shelflife of mussels dried with the L-shaped agro-waste drier and packed in plastic bags was 42 days at 37^{o}, and 36 days for the sun-dried product. Sensory evaluation of the product was made periodically by six trained panelists.

Table 3

Microbiological examination of dried roundscad using solar and agro-waste driers and market samples

Type of drier used/source	Log total plate count	Log yeast and mould count	Log halophilic count
1.0 Solar drier			
1.1 boat type	3.4393	TNC	5.8176
1.2 chair type	3.5428	6.7500	4.4829
1.3 Sta Barbara	3.7634	TNC	5.5092
2.0 Agro-waste driers (using charcoal as fuel)			
2.1 Sta Barbara			
first	8.0	2.6739	5.1987
second	-	4.4346	5.1584
third	-	4.2041	4.4914
four	8.0	TNC	4.4771
3.0 Sun drying	8.0	4.5933	6.4265
4.0 Market samples			
4.1 pasig	7.4200	3.7959	6.9566
4.2 quinta	6.8494	4.1271	6.3596
4.3 farmers'	7.1644	3.8195	6.8096

Table 4

Analyses of moisture content, microbiological counts and sensory evaluation of dried mussel and squid using various driers

Type of drier	Moisture content (%)		Microbiological results (log value)			Sensory evaluation (average scores)		
	Initial	Final	TPC	IMC	HC	colour	odour	texture
A. Mussel								
drier used								
1. chair type solar drier	40.8	24.24	7.952	6.290	4.785	7.0	6.63	6.25
2. agro-waste drier (L-shaped)	40.8	22.48	--	--	--	5.5	5.25	6.625
3. sun drying	40.8	21.26	8.76	6.607	5.064	6.13	6.25	6.25
B. Squid								
1. soldry	79.0	20.3	8.229-	6.716	6.767	8.4	8.5	7.1
2. agro-waste (L-shaped)	79.6	22.5	8.279	6.954	6.886	7.5	7.0	6.4
3. sun-dried	79.6	20.0	8.335	7.004	6.998	7.9	7.8	6.8

Table 5

Equilibrium moisture content (EMC) and water activity (Aw) of squid (*Loligo sp*) using different types of driers as determined by Henderson's plot

Type of drier used	EMC (g water/g solid)		Aw (ERH/100)	
	lower	upper	min	max
solar drier (Sta Barbara)	0.045	0.105	0.09	0.30
agro-waste drier (L-shaped)	0.05	0.10	0.10	0.28
sun drying	0.04	0.075	0.12	0.30

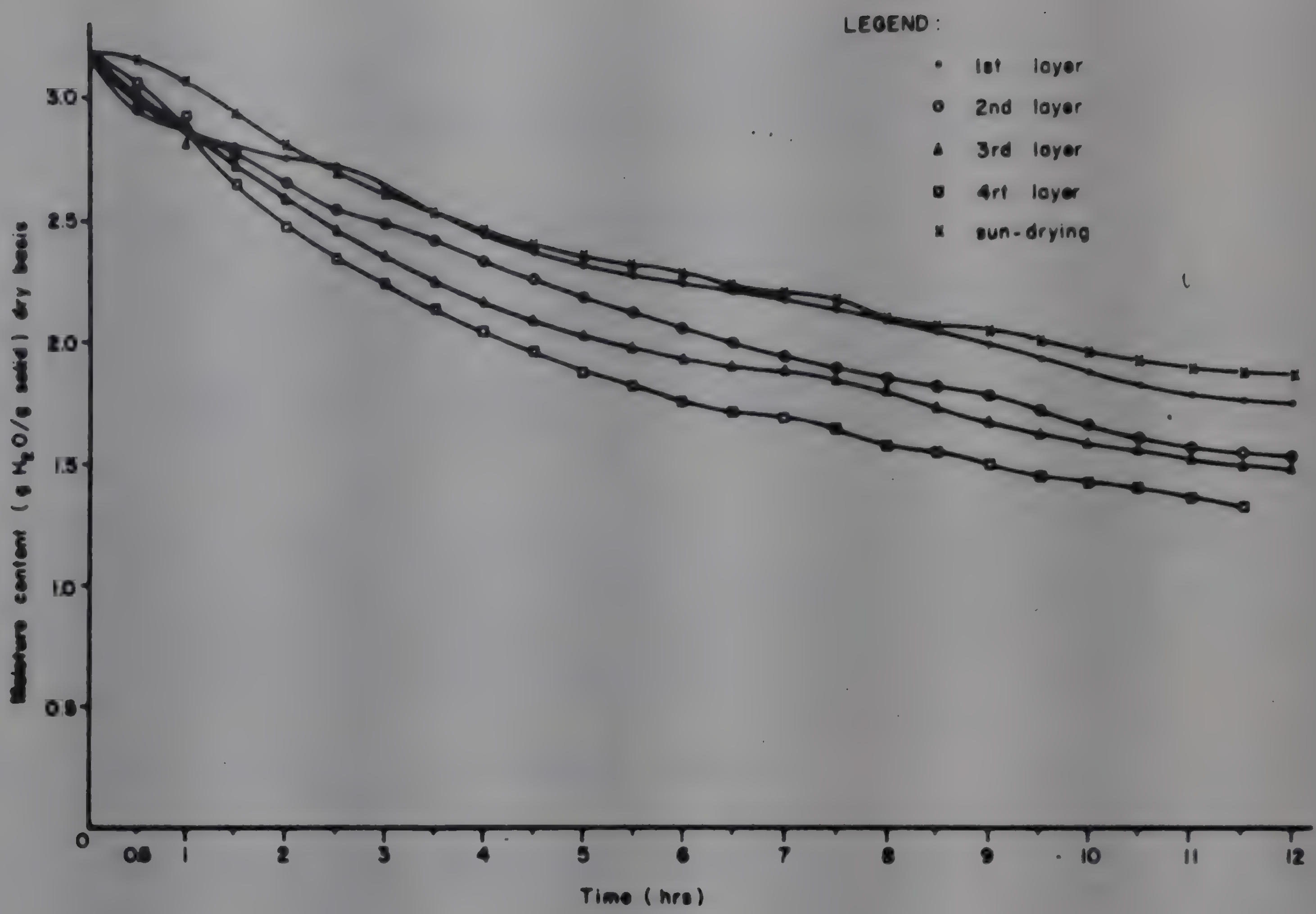


Fig. 7 DRYING TIME CURVES OF ROUNDSCAD (*Decapterus macrosoma*) USING BOAT TYPE DRYER

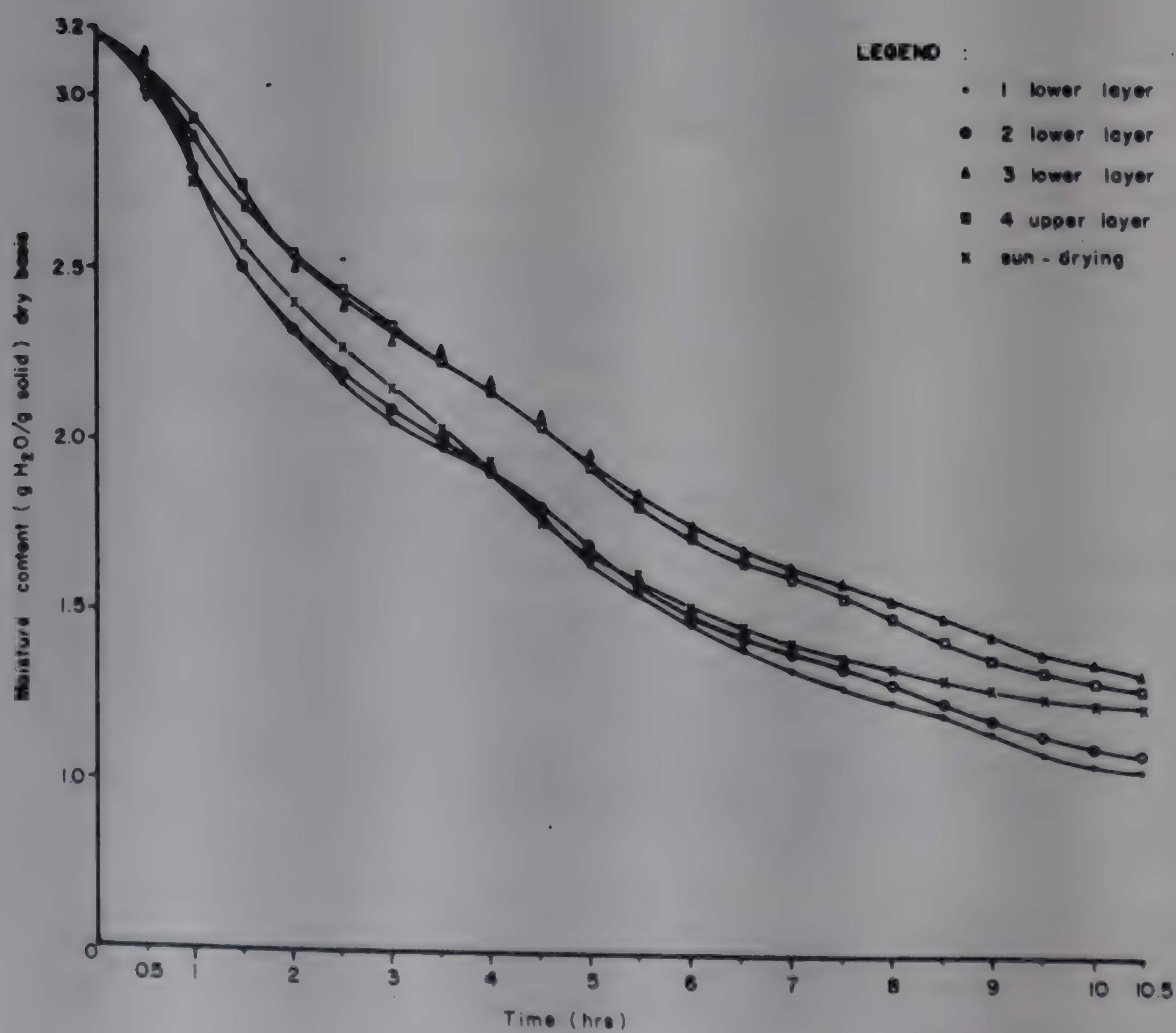


Fig 8 DRYING TIME CURVES OF ROUNDSCAD (*Decapterus macrosoma*) USING L-SHAPED DRYER

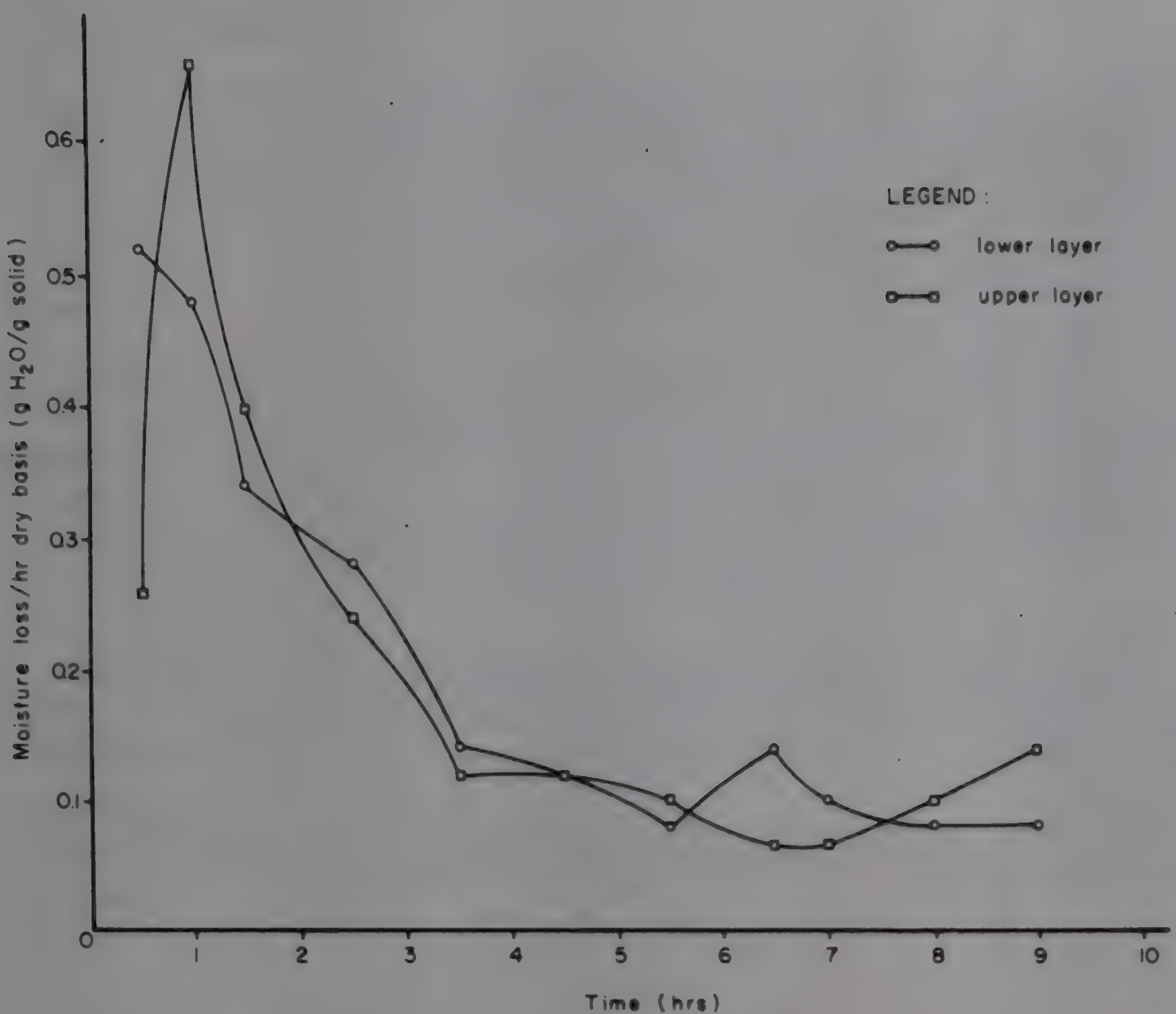


Fig. 9 DRYING RATE CURVE OF FRIGATE MACKEREL (Auxis Thazard Lasepede) USING SOLAR AGROWASTE MULTIPURPOSE DRYER/SMOKER

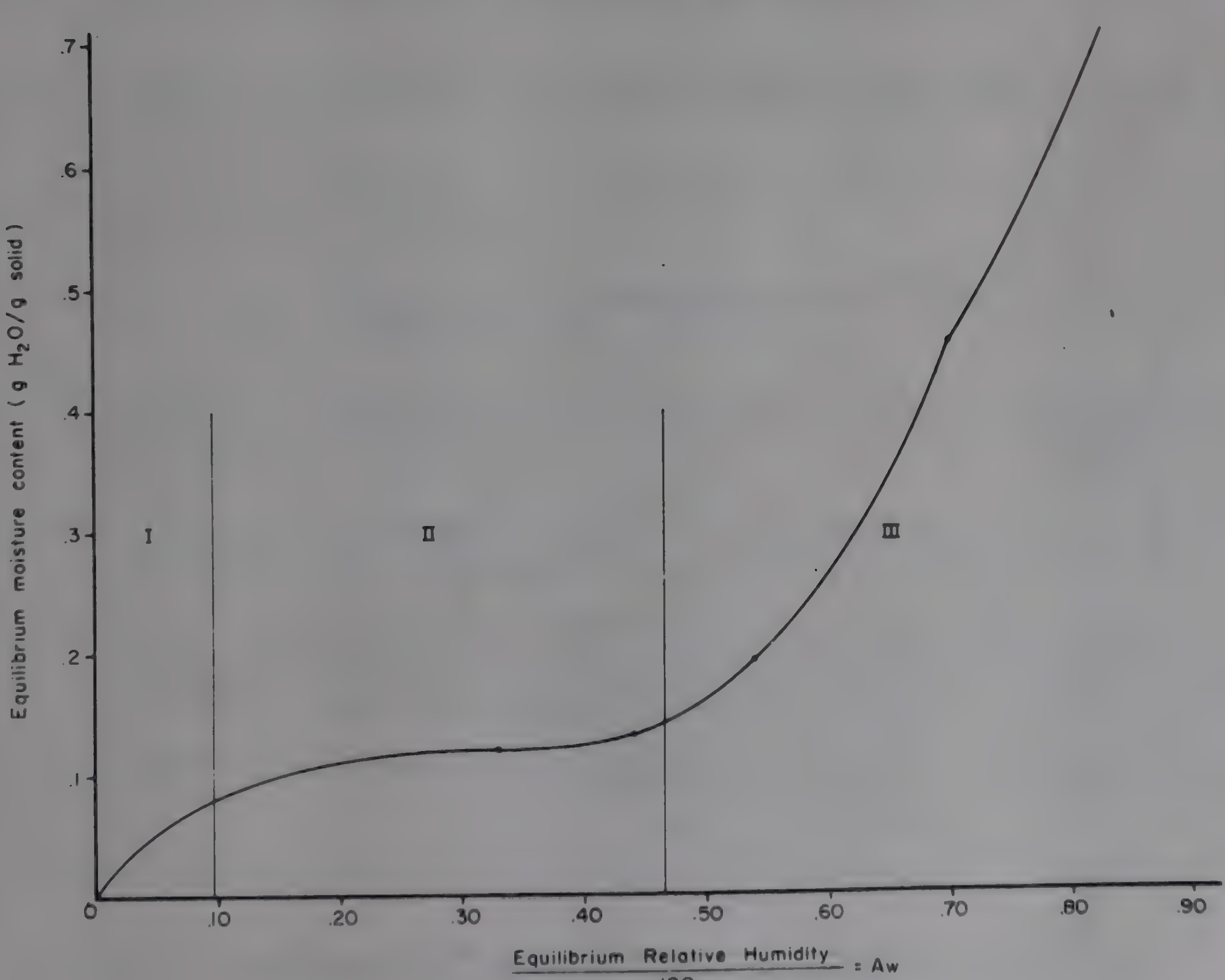


Fig. 10 SORPTION ISOTHERM CURVE OF FRIGATE MACKEREL (Auxis Thazard) USING SAM DRYER

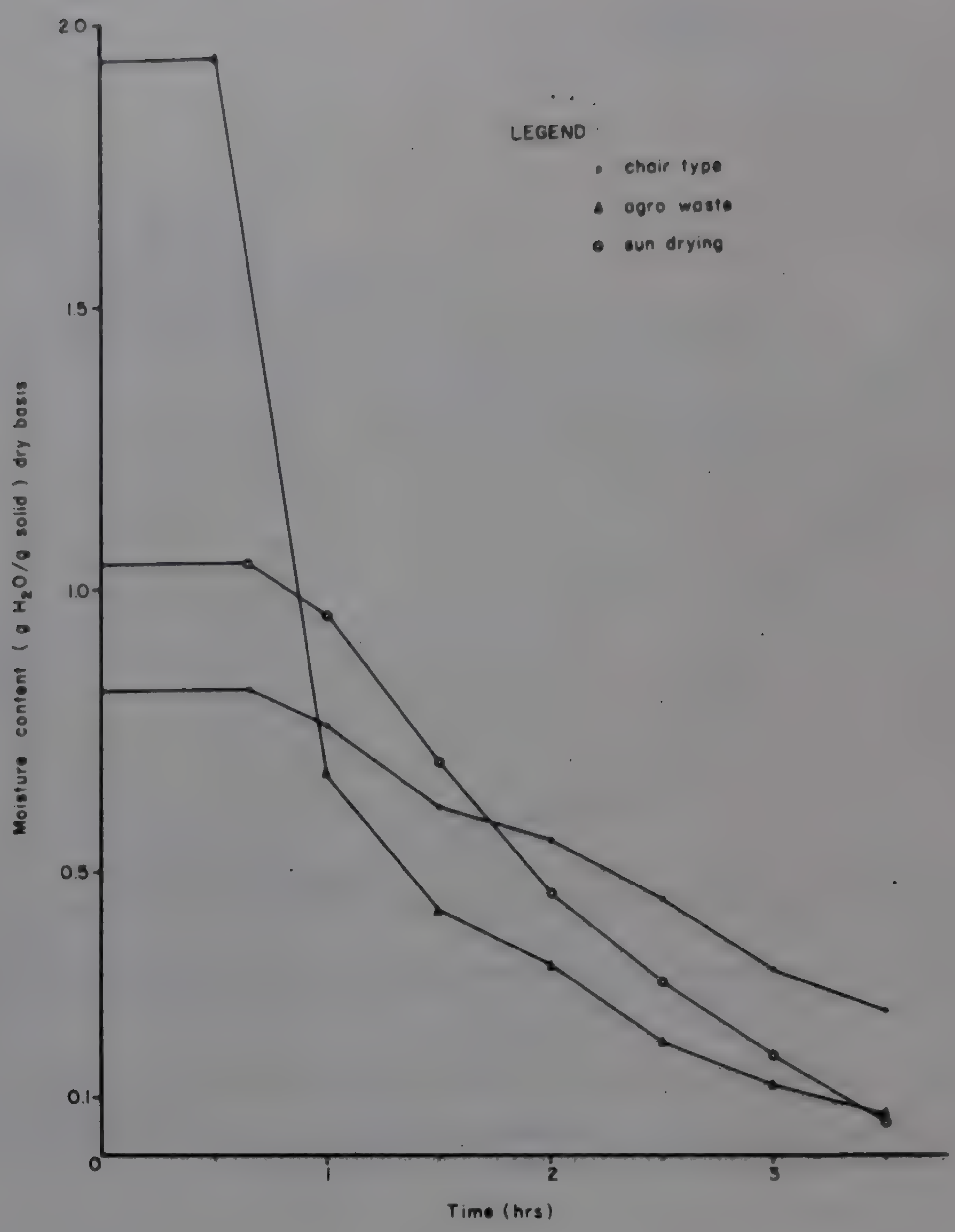


Fig. 11 DRYING RATE CURVES OF MUSSEL (Mytilus smaragdinus) USING DIFFERENT TYPES OF DRYER

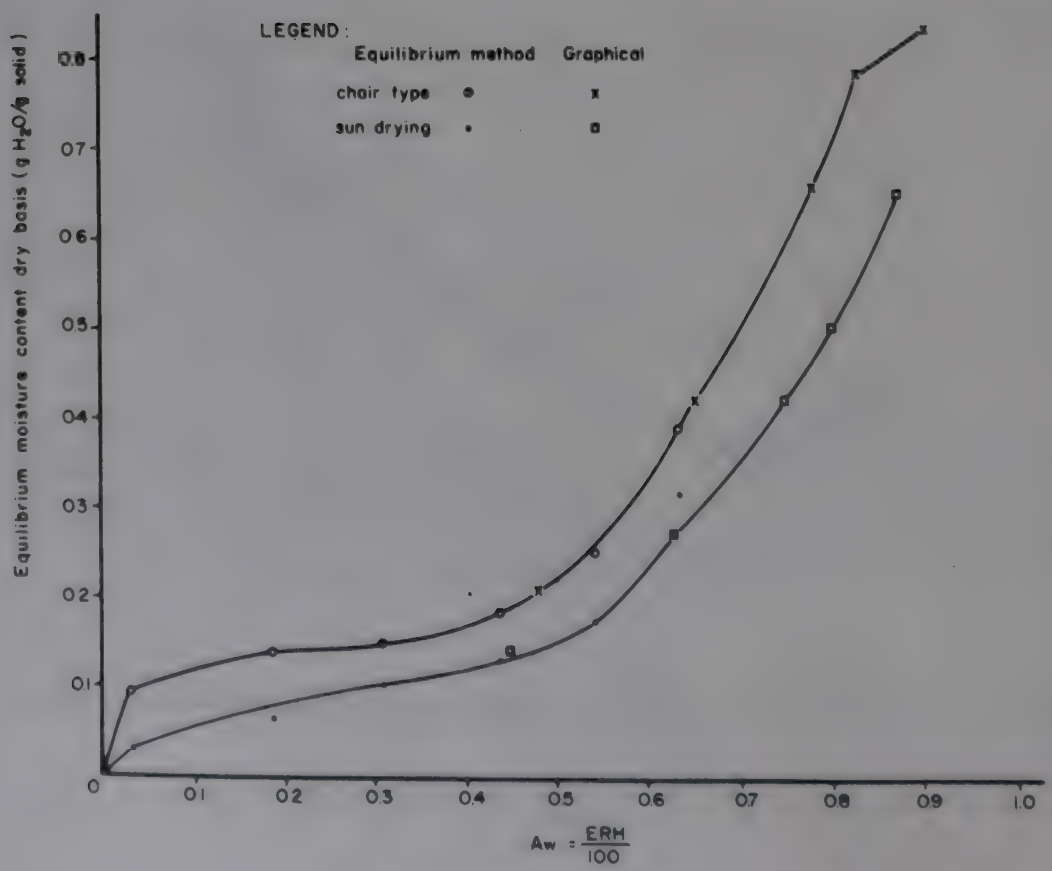


Fig 12 SORPTION ISOTHERM CURVES OF DRIED MUSSELS USING DIFFERENT DRYERS

Drying of Squid (*Loligo* sp.)

Squid (*Loligo* sp.) was dried using the L-shaped agro-waste and the soldry (Sta Barbara) types and compared to traditional method of drying. The initial moisture content of 3.2 (g H_2O/g solid) was reduced to 0.28 using the soldry drier; 0.32 using the L-shaped agro-waste and 0.25 for the sun-dried products (Figure 13). The log total plate count of squid (Table 4) was 8.2-8.3, log of yeast and mould count (6.7 to 7.0) and log halophile count (6.8-6.9) did not vary significantly between the various driers, although sun drying exhibited higher counts. Sensory scores (Table 4) were highest with solar-dried squid.

Sorption isotherm properties of squid dried by using the solar (soldry type) and L-shaped agro-waste driers were compared to the sun-dried samples. Using Wink's equilibrium method, Henderson's and BET plot and based on the sorption isotherm curves, the dried squid using the soldry type (Sta Barbara) showed a wider range of EMC as compared to sun-dried samples (Table 5). Comparison between solar-dried and agro-waste dried samples showed relatively small differences but the former gave superior results.

Based on the final moisture content of each product and all other results obtained, it is therefore, recommended that the samples should be dried to a maximum of 10%, on a wet basis or that the moisture content level must be kept within the limits of region II. Proper packaging materials are also recommended to prolong the shelflife of the product.

Sun-dried products showed lower sensory scores and a shorter range of moisture levels in region II, which may be due to the uncontrolled weather conditions affecting the drying rate of the product.

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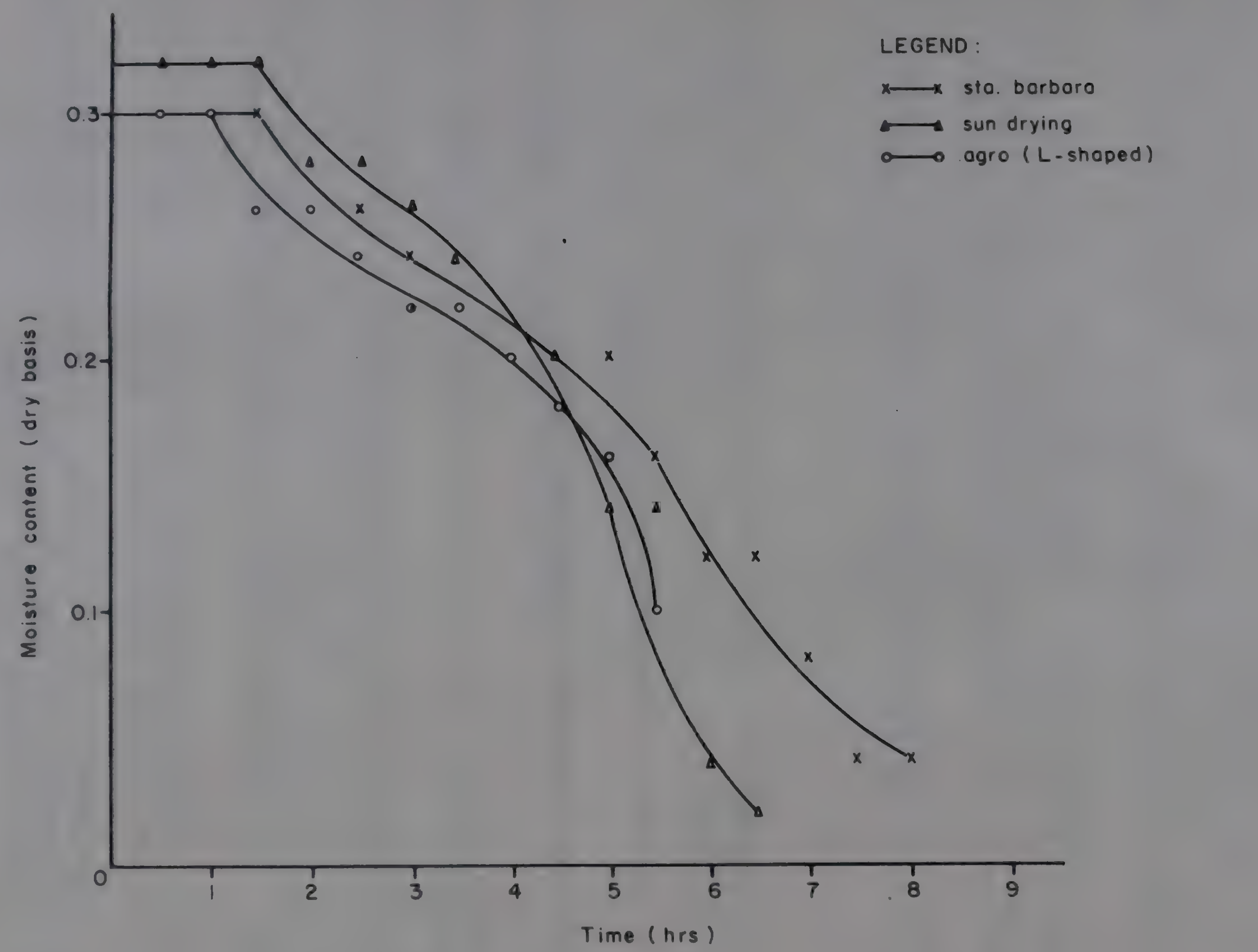

Fig. 13 DRYING RATE CURVE OF SQUID (Loligo sp.) USING DIFFERENT TYPES OF DRYERS

FISH PROTEIN CONCENTRATE FOR HUMAN CONSUMPTION

by

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ABSTRACT

The study was carried out to improve the sandy texture and water absorbence of fish protein concentrate (FPC type B using sorted trash fish as raw material).

The process was modified from traditional smoked-dried fish to create a fluffy texture and better flavour and to enhance aroma. In this experiment three kinds of products were produced: (a) dried ground whole fish (DGWF), (b) dried ground smoked whole fish (DGSWF) and (c) dried ground smoked headed fish (DGSHF).

All products were accepted in terms of appearance, colour, flavour and texture when prepared in three kinds of popular Thai recipes. The smoked type was more acceptable than non-smoked one. The water absorbence of DGWF, DGSWF and DGSHF were 3.2, 3.9 and 4.4 times of the weight of sample, respectively. These products could be introduced as supplementary protein food through nutritional programmes in order to alleviate malnutrition in rural area. However, cost of production, promotion cost and consumer preference in each target area, including many other details, must be considered.

NOTE: These studies were started after the FAO/NORAD Round Table discussion on Fishery Products and the Consumer, Krazer's Hill, Malaysia, 1982, where it was noted that the main disadvantage of FPC type B is sandy texture and poor water resorbing capacity.

INTRODUCTION

In Thailand, trash fish forms an important component of fish by catches. The catch is about 0.8 million t/year, made up of 33.29% young economic fish and 66.71% of under-utilized species. A part of the trash fish could be utilized for traditional products such as smoked and dried ground fish; a product that may be used as a main ingredient in food preparation or as a protein supplement.

MATERIALS AND METHODS

By-catch obtained from a single commercial trawler was used in this experiment. On arrival at laboratory, fish were immediately washed and sorted to eliminate poor-quality fish and foreign matter.

Fish Protein Concentrate Preparation

The fish were divided to three different types of process:

(a) Dried ground whole fish (DGWF) - the sorted fish were cooked in an autoclave at 15 lb/in^2 for 30 min, then shredded to small pieces. The shredded fish were transferred to an oven at 50°C for 3 h and 65°C for another 12 h with mixing thoroughly at 3-h intervals until completely dried. Dried fish were ground with a hammer mill to a powder.

(b) Dried ground smoked headed fish (DGSHF) - The sorted fish were headed, washed thoroughly, drained and then placed on trays and were sun-dried for 30 min. The fish were smoked in a smoked house for 1 h at 50°-55°C using coconut husk as fuel. The smoked fish were dried again for 6 h in a mechanical oven at 60°C and ground with hammer mill.

(c) Dried ground smoked whole fish (DGSWF) - The processing steps of dried smoked whole fish were the same as for the headed sample; the difference was that this type was made from whole fish.

ANALYSIS AND EVALUATION

Each type of product was evaluated by the following parameters:

(a) Chemical analysis - Protein, moisture, fat, ash, calcium and phosphorus were determined using AOAC (1980) methods. Sand was determined using the method of the Draft Proposal No. 39 of ISO/TC 169, at the first meeting in Lima, April 1979.

(b) Water absorbence - Water absorbence was measured using a sample weight of 10 g placed into 100-ml cylinder, and observing the volume. Eighty millilitres of water was added and the mixture was stirred thoroughly and left for 3 h until there was no more absorption. The volume of wet fish and supernatant water were measured to calculate the absorbed water/1 g of dried fish.

(c) Yield - The weight of fish was recorded during the process from initial weight to the finished product to calculate the yield.

(d) Acceptability test - All products were incorporated into three Thai recipes with controlled ingredients. A hedonic scoring method (Table 1) was designed for use in this experiment to elicit the spontaneous opinions of nine panelists as measuring the properties of the group taking part in the test and their interaction with the properties of products (Howgate, 1978).

Table 1

A panel scoring sheet used in this experiment

Department of Fisheries	Score									Name of product ____ Name of panelist ____
Date ______ Item ______	9	8	7	6	5	4	3	2	1	Reason
Appearance Colour Odour Texture Flavour Other										

Comments:

Numerical values:

9 = like extremely
8 = like very much
7 = like
6 = like slightly
5 = neither like nor dislike
4 = dislike slightly
3 = dislike
2 = dislike very much
1 = dislike extremely

RESULTS AND DISCUSSION

Chemical Analysis

The analysis obtained on three kinds of fish protein concentrate is shown in Table 2. Statistical analyses were done to test the effect of different processing methods on the parameters analysed. There were very highly significant differences in the percentage of protein, calcium and sand content. From the means of triplicate analyses, DGSHF had the highest protein content and the lowest sand content compared to the others. This may probably be due to the effect of removing the head. Although DGWF had the lowest protein content, it contained the nighest calcium, therefore, it may be used as a calcium supplement for pregnant mothers. All products from the experiment had quality characteristics above the critical level proposed by PAG (PAG Guideline No. 9, January 1971), i.e., moisture content not more than 10%, lipid no limit, protein not less than 60%, total ash more than 20%.

Table 2

Analytical results obtained on fish protein concentrate[a/]

Sample	Moisture (%)	Protein[b/] (%)	Fat (%)	Ash (%)	Calcium[b/] (%)	Phosphorus (%)	Sand[b/] (%)
DGWF	5.8	62.54	14.07	17.32	6.46	0.22	0.73
DGSWF	6.8	68.5	11.89	14.4	5.36	0.14	0.22
DGSHF	6.7	75.9	10.54	14.6	3.27	0.12	0.07

a/ Mean of triplicate analyses
b/ Highly significant difference 0.001

DGWF = Dried Ground Whole Fish
DGSWF = Dried Ground Smoked Whole Fish
DGSHF = Dried Ground Smoked Headed Fish

Water Absorbence

The effect of different types of product on water absorbence is given in Table 3. There were highly significant differences in absorbed water per gram of ground fish between the samples. DGSHF had the highest water absorption, perhaps due to the low sand content. In the acceptability test, DGSHF obtained slightly higher average scores from the panel than other samples, probably due to the result of water absorbence.

Table 3

The effect of different types of product on water absorbence[a/]

Sample	Volume/ 10 g of sample	Wetted volume (ml)	Expanded volume (ml)	Clear water (ml)	Absorbed water/1 g of sample[b/]
DGWF	34	46	12	48	3.2
DGSWF	41	55	14	41	3.9
DGSHF	43	60	17	36	4.4

a/ Means of triplicate analyses
b/ Highly significant difference $P < 0.001$

Yield

Yields of DGWF, DGSWF and DGSHF were 21%, 16% and 10.5%, respectively. Although DGSHF had very low yield, protein content was high because 40% of the head had been discarded.

Acceptability Test

The results of acceptability evaluation on fish protein concentrate are listed in Table 4. Each score was a mean of 18 judgments (9 panelists x 2 replicates). Statistical analyses were also done to test the effect of processing methods on appearance, colour, odour, texture and flavour of three kinds of fish protein concentrate for each diet. The results were as follows:

(a) Kaeng Raeng - The differences in panel scores on colour, odour and texture were highly significant. Significant differences in flavour and non-significant differences in appearance were found.

(b) Namprik and Pudprikkhing - There were highly significant differences on appearance, colour, odour, texture and flavour.

Table 4

The results of acceptability evaluation scores on fish-protein concentrate a/

Sample	Appearance	Colour	Odour	Texture	Flavour
Kaeng Raeng					
DGWF	6.45	6.45 b/	5.95 b/	6.54 b/	5.45 c/
DGSWF	6.45	5.9	5.63	6.6	5.85
DGSHF	6.9	6.81	6.19	7.39	5.6
Namprik					
DGWF	5.64 b/	5.42 b/	6.21 b/	6.0 b/	5.0 b/
DGSWF	7.35	7.5	7.42	6.92	6.78
DGSHF	5.07	5.78	5.78	5.85	5.42
Pudprikkhing					
DGWF	5.5 b/	5.6 b/	5.0 b/	4.9 b/	5.0 b/
DGSWF	6.5	6.25	5.63	5.25	5.38
DGSHF	6.37	6.88	7.13	6.5	6.88

a/ Each score was a mean of 18 judgments (9 panelists x 2 replicates)
b/ Significantly different $P < 0.05$
c/ Highly significantly different $P < 0.001$

CONCLUSION

The study has shown that many of the problems associated with production of fish protein concentrate, such as colour, flavour and grittiness, may be overcome by using eviscerated fish as raw material.

RECOMMENDATION FOR FURTHER STUDY

Quality and acceptability were closely interrelated. Quality should be measured objectively, that is by procedures where any biases introduced by the person carrying out the test are small and minimized by training. On the other hand, acceptability test by their very nature will be subjective, that is the results will somewhat depend on the panelist.

Furthermore, the cost of production and marketing should be considered.

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BOILED-SALTED FISH (PINDANG) AS A POSSIBLE SUBSTITUTE FOR DRIED-SALTED FISH: PROBLEMS AND PROSPECTS

by

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ABSTRACT

Boiled-salted fish "pindang" is important among traditionally processed fishery products in Indonesia consuming a significant share of the total catch. The products have low salt content as well as specific flavor and good palatability which are regarded as important factors. About 5.5 per cent of total fish catch was processed into pindang although in Java and Bali pindang contributed more than 15 per cent of the total marine fish catch in 1979. Processing of pindang offers good prospects for further development with regard to marketability as well as possible adoption of the processing techniques by other S.E. Asian regions. However, there are problems to be solved especially to improve quality and prolong shelflife. Studies to produce better quality with longer shelflife pindang are discussed. Special emphasis is being given to the technical aspects of pindang production as well as their prospects for substituting dried fish production in Indonesia.

INTRODUCTION

The major nutritional problem in South East Asia is protein-energy malnutrition (PEM) which is the result of a deficiency in both calories and protein (Chong, 1979). The total protein intake of the people is very low and consists mostly of vegetable protein (Putro, 1982). In Indonesia, the annual animal protein intake is only about 12 kg *per caput* while Indonesian Government standards call for 29.5 kg/*caput*/year (Pownall, 1975.

The disproportionate consumption of vegetable protein is due to the availability of cheaper vegetable protein, such as from soybeans, and an insufficient supply of animal protein especially from poultry and cattle (Pownall, 1975; Putro, 1982).

Fish and fishery products are considered to be the most important source of animal protein, providing about 24 percent of the total protein in the outer Java islands, and about 14 percent in Java (Chong, 1979; Putro, 1982). However, fish consumption has been discouraged by high prices and limited supply, coupled with high perishability, especially under tropical conditions. In addition, inadequate marketing and distribution systems, particularly for fresh fish, have all hindered increased fish consumption.

Because of their higher cost and inadequate supply, the nutritional role of meat and poultry is secondary to that of fish. Only about 4 percent of the overall protein supply is derived from meat inclusive of eggs (Chong, 1979). It is obvious, therefore, that fish and fishery products will play an important role in providing animal protein in the coming years.

Ideally fresh fish is the most suitable commodity for human consumption. About 39 percent of total fish catches are currently sold as fresh fish in Indonesia, but fresh fish distribution is restricted by the insufficient supply and high price of ice. Dried-salted fish, the most important commodity among cured fishery products, plays a less significant role in stimulating more fish consumption despite relatively long shelflife

and ease of distribution. Poor quality and high salt content have been blamed for low consumption of dried-salted fish. In this connection it is necessary to improve the existing techniques or to develop new curing methods in order to produce commodities with acceptable taste and good shelflife for wider distribution. Processing of fish into pindang offers a good prospect for further development since it has low salt content and good palatability, lying between fresh and dried-salted fish. In addition, it has a better shelflife compared to fresh fish.

TOTAL CATCH DISPOSITION AND PINDANG PRODUCTION

Processing of pindang is one of the most popular methods of fish processing and preservation in Indonesia. In 1979, about 5.5 percent of the total marine fish catch were processed into pindang, which occupied third place after disposition for fresh fish (45.15%) and dried-salted fish (35.5%) (Indonesia, Direktorat Jendral Perikanan, 1981). This disposition is expected to change in the coming years with a higher percentage for pindang production. Processing of pindang is widely practised throughout the country especially in Java and Bali as shown in Table 1.

Table 1
Disposition of marine fish catch for pindang by province

Province	Total marine fish catch (t)	Total pindang production (t)	Percentage to total marine fish catch
North Sumatra	130 783	134	0.10
West Java	71 377	7 871	11.02
Central Java	118 066	29 676	25.13
East Java	132 149	26 795	20.28
DKI Jakarta	25 024	252	1.00
Lampung	33 489	21	0.06
Bali	20 806	4 237	20.40
West Nusa Tenggara	26 542	3 409	12.8
Central Kalimantan	22 179	30	0.14
East Kalimantan	37 403	6	0.02
South Sulawesi	159 912	2 620	1.6
South East Sulawesi	20 970	203	0.96
Maluku	70 364	854	1.2
Irian Jaya	18 307	43	0.23

Note: Total marine fish catch in 1979 was 1 317 744 t.
Source: Fisheries Statistics of Indonesia, 1981

TECHNIQUES OF PINDANG PROCESSING

In general, pindang can be prepared by cooking fish in a boiling brine solution or by cooking fish-salt mixtures in a metal or earthenware container. Accordingly, there are two major techniques of pindang processing, i.e., brine-cooked pindang and salted-cooked pindang. Brine-cooked pindang is prepared by dipping a mixture of fish and salt which has been arranged in a bamboo basket in a boiling brine solution for several minutes or sometimes hours. After the completion of the cooking time, the baskets are lifted, sprayed or quickly dipped in boiling fresh water to remove the excess of salt, drained and cooled to room temperature. The products are ready for market without further packaging. Salted-cooked pindang is prepared by cooking a mixture of fish and salt in an earthenware or metal container with the addition of a small amount of water. The cooking time is usually longer than brine-cooked pindang (3-4 h). The

remaining liquid is then drained through a small hole at the bottom of the container or by tilting the container. The top surface of the cooked fish is covered with paper and layered with salt to prevent recontamination. The heating process is then continued for 1-2 h before cooling and packing for distribution.

PRESENT STATUS OF PINDANG PROCESSING

Pindang processing is usually carried out as small-scale household industry. The raw materials are processed with simple equipment and technical know-how with a relatively low investment.

Different species of fish can be used for pindang processing, including tuna, oil-sardines, mackerels, milkfish, or even sharks and rays. Small size fish are processed whole, whereas big size fish are commonly processed in chunks. Handling practices of raw materials vary from place to place. In some areas the raw materials are iced or salted on board the fishing vessels, but in other locations there is no pre-treatment of raw materials at all. At the processing centres, the fish are washed with well water and immediately processed, or otherwise temporarily store in a cement tank with the addition of salt.

Although pindang is processed at relatively high temperatures, it is not packed in hermetically sealed containers. Therefore, it is subject to recontamination in the absence of proper packaging. The shelflife of pindang depends on the method of processing. Salted-cooked pindang locally known as "pindang badeng" or "pindang paso" has a longer shelflife than brine-cooked pindang. At ambient temperatures salted-cooked pindang can be stored up to one month, when properly packed in a closed container. The product has a dull appearance due to the accumulation of dirt and fat residues during processing and sometimes suffers from physical damage, too salty taste, a canned-fish like aroma and compact texture. Brine-cooked pindang popularly known as "pindang cue" or "pindang naya" on the other hand, has shorter shelflife (2-3 days). However, it has a cleaner and shiny appearance which still reflects the specific color of the fish species and less physical damages. It gives good palatability, mild salt taste, and a boiled-fish like aroma. The texture is soft and moist.

During storage pindang products are susceptible to microbial spoilage especially recontamination after the boiling process.

Brine-cooked pindang (pindang cue) usually suffers from slime formation after 2-3 days. This bacterial activity is facilitated by the low salt and high moisture content of the product. Salted-cooked pindang (pindang badeng), on the other hand, is more susceptible to mould growth especially if the heating process is prolonged. In addition, excessive heating sometimes causes burning and other physical damage. Insect and rodent infestation is also common especially if the product is not properly closed during storage or the cooling process.

Another problem of pindang production is inadequate sanitation of pindang processing equipment and premises. Insufficient and poor quality of water for cleaning is the main handicap for producing pindang in a hygienic way. Improper design and construction of the pindang processing "houses" makes the cleaning operation more difficult. Apparently there is a need for intensifying extension programmes to the pindang processors with regard to sanitation and hygienic principles.

Due to their short shelflife, pindang products especially brine-cooked pindang (pindang cue) have a very limited radius of distribution and have to be distributed and sold immediately. Efforts to improve the shelflite of pindang are, therefore, an important task.

RESEARCH PROGRAMMES TOWARD IMPROVEMENTS OF PINDANG QUALITY

The main difficulties in rationalizing pindang production is the variability of the quality of raw materials as well as the methods of processing from place to place. This results in the production of different quality of pindang with regard to acceptability, moisture content, salt content, and other organoleptic properties.

Nevertheless some efforts have been devoted toward improvement of pindang quality. Darmoredjo and Saleh (1972) suggested the use of salt to maintain the freshness of raw material in the absence of ice. Sri Kumalaningsih (1980) found that good results can be obtained using 15 percent salt, and further improved with the incorporation of potassium sorbate. Biochemical and microbial changes during pindang processing and storage have also been studied (Ilyas and Hanafiah, 1980; Suparno, Bustaman and Hanafiah, 1980; Hanafiah and Sri Hendarti, 1980; Suparno and Trimurtini, 1980). These studies include the pattern of heat penetration, salt penetration, microbial destruction, TVB and TMA changes as well as organoleptic changes. Ilyas and Hanafiah (1978) postulated that practically all microorganisms were destroyed during the heating process of pindang. They suggested that recontamination after processing is the main source of spoilage microorganisms. Improvements of the heating process followed by proper packaging have been found to prolong pindang shelflife (Nitibaskara and Dollar, 1967; Ilyas and Darmoredjo, 1968; Ilyas and Ronsivalli, 1969).

The ratio between salt and fish also plays an important role in determining the shelflife and the extent of lipid oxidation of pindang (Nitibaskara and Dollar, 1967). The use of preservatives without proper packaging showed little effect, although sorbic acid has been suggested as useful for prevention of mould growth (Syachri and Nur, 1979).

Studies on the effect of water activity (a_w) and manipulation of other physical properties of pindang as well as the use of chemical and biological preservatives to improve pindang quality and shelflife are in progress (Putro, unpublished). Efforts toward standardization of pindang processing are also being carried out.

PROSPECTS FOR FURTHER DEVELOPMENT

Although problems remain to be solved, prospects for pindang development and introduction of the processing techniques into other regions seem to be promising. Pindang offers several advantages compared to dried-salted fish:

- It has low salt content and good palatability, therefore, can be consumed in larger quantities and used as an important source of animal protein. Dried-salted fish consumption on the other hand, is usually very limited due to the salty and unpleasant taste.
- Pindang products are widely accepted by people from different regions and ethnic backgrounds.
- The technology is relatively simple and requires only simple equipment; and unlike drying it is independent of weather conditions.
- Like production of dried-salted fish, any fish species can be used for pindang production.

Further improvement of pindang quality and shelflife are still imminent, including:

- Manipulation of a_w and other physical properties of pindang.
- The use of plastic pouches to improve the shelflife and marketability.
- The use of approved chemical preservatives or suitable biological activities to prolong pindang shelflife.
- The application of refrigeration techniques is most suitable for storage and distribution of pindang, although for the time being the techniques are still economically unfavourable. However, it might become the best means for distribution and prolong the shelflife of pindang in the future.

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FISH SATAY PROCESSING IN MALAYSIA

by

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ABSTRACT

In Malaysia fish satay is produced by small-scale processors using the by-catch of yellow goatfish (*Upeneus sulphureus*, Cuv.) as the main raw material. A survey of existing processing methods shows that the preparation of fish satay is simple and requires very little investment and technical know-how. The average chemical composition (% ODB) of market samples is as follows: 4.7% moisture, 55.5% crude protein (N x 6.25), 4,3% fat and 5.4% ash.

Fish satay was also developed at the laboratory under more controlled conditions to standardize the quality of the product.

INTRODUCTION

In Malaysia, some 77 240 t of fresh fish was utilized for drying, salting or smoking in 1980. This constitutes 31% of the total amount of fresh fish utilised for processing including canning and traditionally processed products, such as crackers and fermented fishery products. In the same year, 7 994 t of salted fish, 9 437 t of dried anchovies, 1 268 t of dried prawns, 1 297 t of dried cockles and 200 t of dried cuttlefish were produced in Peninsular Malaysia (Annual Fisheries Statistics, 1981).

Fish satay is produced on the island of Pangkor, which is situated off the West Coast of Peninsular Malaysia. Several establishments are also operating in the mainland areas of Perak namely Sitiawan and Pantai Remis. Fish satay is usually made from the by-catch species, yellow goatfish, *Upeneus sulphureus*, Cuv. (local name "ikan biji nangka") which is characterized by a bright yellow stripe from the eye to base of upper caudal lobe. This fish is small in size averaging 7-10 cm in length and by virtue of its size, it poses technological difficulties in the separation of the flesh. Prior to being used for fish satay, the yellow goatfish was utilized as manure or reduced to fishmeal for incorporation into animal feed rations (Chee, 1980). In 1980, some 1 292 t of this fish was landed in the country.

This paper outlines the existing methods employed in the fish satay industry in Malaysia. It also includes the quality of the products available in the market and results of a study on fish satay development in the laboratory.

MATERIALS AND METHODS

Fish satay processing establishments on the island of Pangkor were visited to study the existing method of production by these processors. Interviews were conducted and samples were taken and analysed in the laboratory.

Development of fish satay was also carried out in Serdang. On arrival the heads and scales were removed. The fish was split ventrally and opened butterfly fashion whereby the viscera and backbone were removed. The cleaned fish were dried for 1½ hours at 40-45°C in the dehydrator followed by a higher temperature of 55-60°C till a moisture content of 10-11% was achieved. The dried fish was cooled, rolled and dipped in sauce containing ingredients in proportions given below (Table 1) before oven drying at 150°C for 25 minutes.

Table 1

Ingredients for fish satay souce

Ingredients	Weight (in g)
Sugar	110
Salt	5
Chilli powder	15
Pepper	3
MSG	2
Ginger	20
Water	400 ml

RESULTS AND DISCUSSION

Observations at the Fish Satay Processing Sites

There are 23 fish satay establishments in the island of Pangkor. These are mainly small-scale producers with or without any formal factory site. A majority are more of a backyard type of operation.

The main raw material used for fish satay production is the yellow goatfish. This type of fish is purchased direct from trawlers at M.$ 0.25-0.50 per kg depending on the species, size and season. The steps involved in the production of fish satay are as follows: dressing, sun drying, cooling, rolling, dipping in a thick sauce and oven drying.

The tail, scales and head are removed followed by a ventral split all the way from the gut cavity towards the caudal region, without cutting through the skin along the back of the fish. The fish is opened out butterfly fashion followed by removal of entrails, peritoneum and kidney tissues adhering to the backbone. A cut is made beneath the ribs down to the backbone followed by removal of the backbone. The fish preparation is similar to that employed in the preparation of split fish for salting and drying (Rogers, Cole and Smith, 1975).

The fillets are than arranged on netted, woven or wired racks. Alternatively they are arranged on cemented floors lined with kraft paper. The fish is dried for 1-3 days depending on the weather. The dried fish is sold in woven baskets to fish satay processors at M.$ 4.00-6.50 per kg. At the factory the fish is rolled using one or two step rollers and dipped in a thick sauce containing sugar, chilli powder, soya sauce, ginger, salt and pepper. The processors were reluctant to disclose formulations used. The fish are arranged on wire racks and oven dried for 10-45 min. After cooling the fish are packed in pairs (net weight 10-12 g per pack) in 0.1 mm polypropylene measuring 9 x 12 cm. These are available in the market at M.$ 0.20-0.30 per pack.

The chemical composition of fish satay obtained from the market varies considerably depending on the type and chemical composition of the raw material and the nature of sauce used. Table 2 shows that the greatest variation lies in the protein content of the fish satay, ranging from 47.3%-58.6%.

Table 2

Chemical composition of fish satay (% wet weight)

Chemical composition	Range (%)	Average (%)
Moisture content	2.1-8.9	4.7
Crude protein (N x 6.25)	47.3-58.6	55.5
Fat	2.3-7.5	4.3
Ash	5.2-6.2	5.4

Product Development in the Laboratory

The fish used in the laboratory has the following chemical composition (% wet weight): 77.0% moisture, 16.4% crude protein (N x 6.25), 2.8% fat and 4.3% ash.

During the drying of fish, a low initial temperature was used to prevent case hardening. This was followed by a higher temperature of 60°C as mentioned earlier. Imperfect control of the dehydration process would eventually impair the quality of the product causing undesirable physical and chemical damage such as cracking and tendency to lose texture upon storage.

The initial drying of fish at 40-45°C resulted in a moisture drop of 3.7%, that is from the initial level of 77.5% to 74.6% after 1½ hours drying. There was a further drop of 80.9% before the final moisture level of 11.9% was reached. Cooling is essential to avoid breakage during rolling. After cooling to room temperature the dried fish was rolled to facilitate better penetration of sauce ingredients into the flesh. The rolled fish was dipped in sauce and oven-dried at 150°C for 25 min. The initial moisture loss after the first 5 min of oven drying was 59.6%, that is, from 21.8% to 8.8%. This rapid rate of drying indicated the removal of free water from the product whereby a high proportion of the total water is removed at this stage. This was followed by a slower rate of drying as shown in Figure 1. After another 20 min of oven drying the moisture level decreased from 8.8% to 3.7%. The total moisture loss of the wet product was 83.0%.

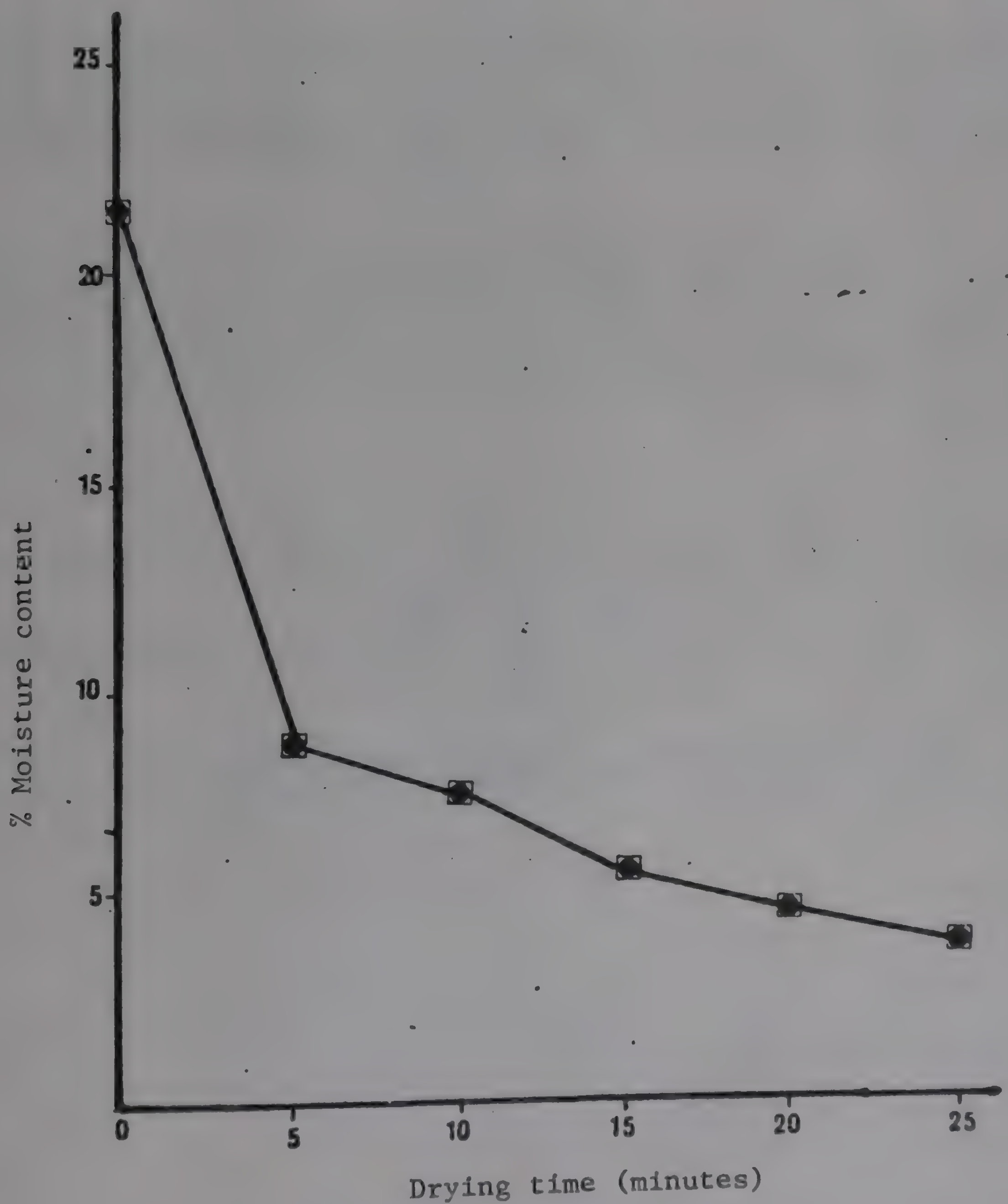

Figure 1 Moisture loss during oven drying of fish dipped in sauce

The product was found to be acceptable organoleptically in terms of colour, aroma, texture and taste. However further storage studies on the product need to be conducted whereby the chemical, microbiological and organoleptic assessment of the product is made by using selected packaging materials.

4. RECOMMENDATION AND CONCLUSION

The traditional method of fish satay processing is basically a simple process requiring very little technical know-how. It is prepared by several steps namely sun drying of dressed yellow goatfish, cooling, rolling, dipping in sauce and oven drying. The processing requires little investment apart from the purchase of a roller and ovens for drying.

The average chemical composition of fish satay obtained from the market were found to be: 4.7% moisture, 55.5% protein (N x 6.25), 4.3% fat and 5.4% ash. Variability of the products was mainly due to variation in the raw material used and in the formulation of the sauce for dipping the dried fish. Basically the method of production employed by small-scale producers in the island of Pangkor was the same.

The fish satay produced in the laboratory was found to have a moisture content of 3.7%. The fish was observed to lose 84.6% of its moisture content on drying. After dipping in sauce containing chilli powder, pepper, ginger, sugar, salt, flavouring ingredients and water, it attains a moisture level of 21.8%. On oven drying, the moisture content was lowered to 3.7%.

Fish satay production in the country can be standardized by the introduction of mechanization in the form of a dehydrator. This would enable a better drying rate under controlled conditions of temperature, relative humidity and air velocity yielding a more standard product. It would also increase output since the operator is independent of the weather to dry the fish.

Finally the fish satay provides a means of increased consumption of small-sized underutilized species of fish which would otherwise be channelled towards fish meal or manure production. The product is simple to make, requires little investment and can be formulated to suit demand. Increased utilization of such underutilized species in the form of this snack product would therefore reduce waste as well as increasing the protein consumption amongst the people.

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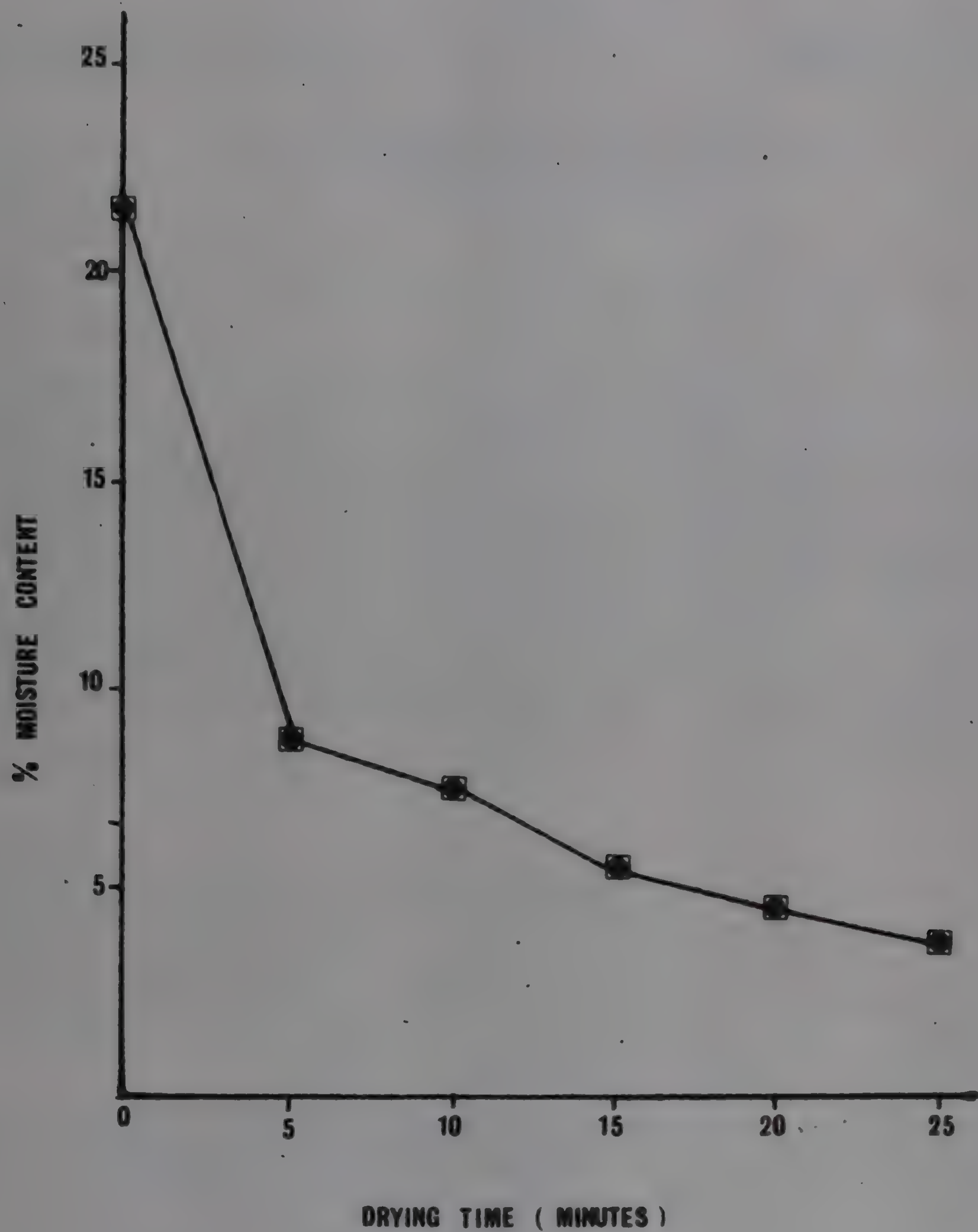

Figure 1 Moisture loss during ovendrying of fish dipped in sauce

INSECT INFESTATION OF DRY FISH IN SRI LANKA

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ABSTRACT

Fish drying methods in Sri Lanka are described and a review presented of the insect species infesting dried fish products in tropical areas. Studies in Sri Lanka, on imported dried fish and domestic product, were undertaken to identify species of infesting insects and extent of losses caused by insects. Results showed that after five weeks storage of local and imported fried fish, *Necrobia* spp. were abundant, while *Dermestes* spp., earlier present in high number, were decreasing. As the fish became powdery, *Tribolium* spp. were observed. There were indications that 30-50 percent of imported dried fish was damaged by insects in the first fifty days of storage. Losses in local product, while apparent, were less severe due to faster consumption.

BACKGROUND

Ninety percent of the marine fish production in Sri Lanka is consumed fresh and the other ten percent is processed into cured products. Dried fish is an economical source of animal protein and much preferred by Sri Lankans. Local production of dried fish accounts for about 25 percent of consumption and imports make up the balance. Dried fish has been imported to Sri Lanka since the 19th century and at present is being supplied mainly from India, Maldives, Pakistan and Singapore.

Fish is cured in Sri Lanka by traditional methods like sun drying, smoking and salt drying. Drying is the simplest and the oldest type of food preservation adopted by the fishermen of Sri Lanka. In sun drying, landed fish are spread on the beach or on a mat and dried. Fish may also be smoked over a fire or in kilns. Salting is done either by stacking the split fish with dry salt between the layers or by immersing the fish in brine.

In Sri Lanka most of the dried fish is produced in the Jaffna District (northern part of the island), Mannar and Puttalam (western coast). Dried fish is produced from marine fish as well as freshwater fish. Table 1 indicates the varieties of dried fish cured in Sri Lanka.

Losses in cured fish are due to a variety of causes which render the fish unfit to eat. There is physical destruction and the nutritional value of the product too is thereby lowered. Losses begin immediately after harvest, because of the lack of means to preserve the catch until landed. Significant losses are caused by enzymatic spoilage and insect infestation while the catch is landed and processed on the beach and awaits transportation to market. Further heavy losses are caused by primitive methods of handling, preservation, transportation and exposure at market (Nat.Acad.Sc., 1978).

Insects cause greater damage to cured fish than bacteria, fungi or mites. Several species of mites (Sachithananthan, 1976) and several species of insects cause heavy damage to dried and Maldive fish, resulting in high economic losses. Because of insect infestation there are qualitative losses too.

Table 1

A list of locally-produced dried fish varieties generally available in the market

Scientific name	Common name
Scoliodon sp.	Shark
Amphotistius sp.	Ray
Sardinella sp.	Sardine
Ilisha elongata	Slender shad
Dussumieria acuta	Common sprat
Gonialosa manninna	Gizzard shad
Anchoviella indica	Indian anchovy
Thrissocles sp.	Anchovy
Chirocentrus dorab	Wolf herring
Tachysurus sp.	Garfish
Hemiramphus marginatus	Half beak
Exocoetus sp.	Flying fish
Sphyraena sp.	Sea pike/barracuda
Mugil sp.	Grey mullet
Therapon sp.	Perch
Megalaspis cordyla	Soad
Caranx sp.	Horse mackerel
Caranx sp.	Jack
Choriemus lysan	Talang, leatherskin
Leiognathus sp.	Pony fish
Otolithus sp.	Jewfish
Drepane punctata	Spotted bat fish
Tilapia mossambica	Tilapia
Rastrelliger kanagurta	Mackerel
Katsuwonus pelamis	Skipjack
Scomberomorus commersone	Spanish mackerel

While curing, moist fish is susceptible to damage by blow flies and their larvae in particular. In Malawi dried fish were attacked by *Chrysomya abliceps, C. chloropyga putoria* and *C. negalis* Desvoidy (Meynell, 1978a). Ahmed *et al.* (1978) recorded that *Lucilia* sp. infested dried fish in Bangladesh and *Wohlfantia* spp. was observed in dried fish by Cole (1968) and Green (1967) in Aden. Usually blow flies attack unsalted dried fish (McLellan, 1963).

Jayawardena *et al.* (1980), reports that in Sri Lanka there is contamination of fish by blow flies, since most beaches are polluted because of limited public sanitation facilities in these areas.

While blow flies attack fish early in the curing process, beetles infest partially and fully cured fish. *Dermestes* spp. are recorded as the major insect infesting dried fish. *Dermestes maculatus* Degeer and *D. frischii* kagelanna infest dried fish in tropical countries (Hinton, 1945). *D. frischii* was found to attack dried fish in Saudi Arabia (Proctor, 1976). *D. aten* Degeer was observed to infest dried fish in Indonesia (Kalshoren, 1954), Aden (Green, 1967), Zambia (Proctor, 1972) and in South India (Pillai, 1957). Ahmed *et al.* (1978) report *D. carnivorus* Fabricius attacking dried fish in the Philippines.

Aref, Timbley and Daget (1965) studying the destruction of unsalted-dried fish during distribution and storage in Male estimated that about 50 percent of the weight of the fish was lost due to *Dermestes* spp. This figure was obtained by actual measurements of the weight losses of fish samples kept in a commercial dried fish store for six months. In Nigeria, Rollings and Hayward (1963) put product losses at 50 percent due principally to *Dermestes* spp. infestation.

Osuji (1973) noted that smoked fish wiht a moisture content of below 10 percent generally showed no infestation but moisture contents between 13 and 16 percent were very conducive to insect infestation. The level of losses due to *Dermestes* spp. is directly related to the length of storage of fish.

When dried fish is stored for six months, there is tremendous infestation by these beetles. The loss of 50 percent by weight due to *Dermestes* spp. attack of unsalted dried fish stored for several months under current commercial conditions in a region with a dry hot climate may be a reasonable estimate.

In Sri Lanka, salted-dried fish such as leatherskin and catfish are only slightly infested by beetles, viz. *Dermestes* spp. (Goonawardena and Etoh, 1980). Infestation in unsalted sprats is so great that after two months only the bony skeleton is left. Percentage meat left after 50 days of storage is 12 percent (Goonawardena and Etoh, 1980).

The precise relationship between levels of losses and salt content remains unclear but salt has a marked protective effect (FAO, Fish.Tech.Pap., 1981).

Besides *Dermestes* spp. there are other beetles which infest cured fish. Aitken (1975) and Proctor (1976) report that *Necrobia rufipes* Degeer (family Cleridae) attacks cured fish throughout the tropics. Osuji (1977) found dried fish to be more suitable diet for *N. rufipes* than either copra or groundnuts. The larvae are predators and may eat the eggs and larvae of *Dermestes* spp. (Simmons and Ellington, 1925). There are three or four larvae moults. Under optimum conditions the species may increase about 25 fold in a period of four weeks (Howe, 1965). Adults are active fliers and disperse themselves very effectively by this method. Other beetles which are sometimes found on dried fish but which appear to be no more than incidential include *Tribolium castaneum*, *Trogoderma granarium* and *Lasioderma serricorne* (Proctor, 1976).

From the above literature review it is seen that studies on actual quantitative loss (by weight) of dried fish due to insect attack are very rare, though there are a number of estimations. In Sri Lanka this type of study has not been reported except for the study of loss in weight for sprats by beetles carried out by Goonawardena and Etoh (1980). Hence in this paper an attempt has been made to determine the degree of loss in dried fish due to insect attack. Insects attacking dried fish were identified. The second stage of the survey will be to find out the remedial measures for these insect infestations.

EXPERIMENTAL

Local dried fish were purchased from different curing yards in the Jaffna district (northern part of Sri Lanka). Three common and popular varieties were chosen for the study, viz. *Tachysurus* sp. (catfish), *Sphyraena* (barracuda) and *Raia* spp. (skate) etc. Two fishes from each variety were weighed individually and tagged. The first sample was used for weight measurements only, while the second was used for moisture and salt content determination. From the second sample of each variety, approximately 30 g of flesh was cut off to determine the dry matter, salt content, ash and protein content. These fishes were then packed inside the "chippams" (coconut palm leaves made into a box) along with the other dried fish, and transported to Colombo by lorry to be stored in retail shops.

Once the dried fish arrived in Colombo, samples were weighed again and moisture and salt content determined. The samples were kept in retail shops. Once these were sold out, sampling was stopped. Right through the storage period, weekly weight measurement, percentage dry matter and salt content were determined.

Moisture Content

Duplicate samples (2 g) were weighed into a porcelain crucible (dried 1 h/100^{o}-$105^{o}C$ and cooled in dessicator for 20 min) and placed in the drying oven (100^{o}-$105^{o}C$) for 24 h. Crucible was cooled in a dessicator for 20 min and weighed.

$$\frac{\text{Weight of wet sample - weight of dry sample}}{\text{Weight of wet sample}} \times 100 = \text{\% Moisture (wet basis)}$$

Salt Content: (wet basis)

Salt was determined as chloride where the ions are precipitated by silver nitrate and the excess silver ions are determined by titration with potassium thiocyanate (Pearson, 1970). Sample (one gram) was weighed into a volumetric flask (250 ml) to which approximately 0.1 N $AgNO_3$ (40 ml to 50 ml) and conc. HNO_3 (15 ml) were added and the flask heated slowly until the sample was completely dissolved. The flask was cooled and the liquid filtered to a volumetric flask (500 ml), rinsing the flask first thrice with distilled water.

To this volume 10 percent ammonium iron sulphate indicator (about 5 ml) was add and the solution was titrated with approximately 0.1 N Potassium thiocyanate until the colour of the solution changes into a faint red-brown.

$$\frac{5.85 \times (\text{ml } AgNO_3 - \text{ml KSCN} \times f)\ n}{10 \times \text{weight of sample}} = \text{\% salt (wet basis)}$$

All anaylysis were performed in duplicate.

Dried fish imported to the island are stored in the main stores situated at Welisara and distributed from here to various parts of the island. Out of these, four popular varieties of dried fish were chosen for the study. The varieties are *Katsuwonus pelamis* (skipjack), *Tachysurus* sp. (catfish), *Chorinemus lysan* (leatherskin) and shark fillets. Once the dried fish was brought to the stores, random samples were selected, weighed, tagged and stored. During the storage period percentage loss in weight, moisture content and salt content were analysed weekly.

RESULTS

Identification of the types of insects observed in samples during the storage period were *Dermestes frischii* (hide beetles) - family Dermestidae - *Necrobia rufipes* (red legged ham beetle) - family Cleridae - *Tribolium* spp. (Tenebrionidae family). These three varieties of insects are beetles of the order Coleoptera. During the early stages of storage, *Dermestes* spp. were abundant while *Necrobia rufipes* were fewer in number but after approximately five weeks, *Necrobia* spp. outnumbered *Dermestes*. After the 6th week storage small reddish brown insects were found feeding on dried fish. These are Tenebrionids which belong to the family Tenebrionidae. Change in weight, moisture content and salt content of imported and local dried fish are shown in Tables 2 to 7.

Table 2

Change in weight during storage of imported dried fish

Storage period (days)	Catfish (g)	Leatherskin (g)	Sharkfillets (g)	Skipjack (g)
0	575	1 030	240	505
13	480	950	210	480
37	460	925	220	455
42	440	900	205	445
47	435	820	200	440

Table 3

Change in moisture content of imported dried fish during storage

Storage period (days)	Catfish (%)	Leatherskin (%)	Sharkfillets (%)	Skipjack (%)
0	48.458	47.439	43.505	39.60
13	38.740	45.161	41.882	43.45
37	37.700	40.481	38.759	41.86
42	30.330	37.930	36.370	29.92
47	22.107	41.819	38.538	38.136

Table 4

Change in salt content during storage of imported dried fish

Storage period (days)	Catfish (%)	Leatherskin (%)	Sharkfillets (%)	Skipjack (%)
0	10.5113	9.77	12.55	12.89
13	21.5685	16.42	14.71	13.76
37	20.30	13.73	11.98	14.76
42	21.10	18.08	14.21	16.71
47	22.30	17.42	16.06	14.14

Table 5

Change in weight (g) during storage of local dried fish

Storage period (days)	Catfish (g)	Barracuda (g)	Skate (g)
0	835	500	2 412
4	835	490	2 502
14	825	490	2 555
24	800	430	2 413

Table 6

Change in moisture content during storage of local dried fish

Storage period (days)	Catfish (%)	Barracuda (%)	Skate (%)
0	43.07	41.69	55.95
4	47.29	40.47	44.38
14	45.44	39.77	51.26
24	46.76	41.80	49.04

Table 7

Change in salt content during storage of local dried fish

Storage period (days)	Catfish (%)	Barracuda (%)	Skate (%)
0	14.55	15.49	11.46
4	18.87	18.80	15.07
14	12.13	17.26	13.86
24	17.02	18.40	15.20

DISCUSSION

From our studies it is seen that after five weeks of storage of imported dried fish, *Necrobia* spp. were abundant, while *Dermestes* spp. were decreasing in number, which shows that *Necrobia* spp. are preying on eggs and larvae of *Dermestes* spp. *Tribolium* sp. (flour beetle) were observed as the dried fish becomes powdery.

Among the four species of imported dried fish, shark meat is less contaminated by insects. This may be caused by the strong ammoniacal odours. This is a common observation in the Welisara stores. Therefore, most of the weight decrease of dried shark is due to some other reason such as moisture decrease.

From the tables we can observe that the moisture content varies widely. Since the moisture content was determined from a small sample cut off from the dried fish it does not represent the moisture content of the whole fish. Assuming that the moisture content of the sample is stable throughout the storage period, weight of the sample decreases, as seen in Tables 2 and 5. This obviously shows that within 50 days of storage 3% to 60% of fish is eaten by insects. Further taking into account that the fish eaten by insects is partly used to increase their weights and partly discharged as excreta, the actual amount eaten by insects is more than what is recorded as weight loss.

In determining the extent of the actual damage, corrections must be made for the loss of protein and fat in the energy used for metabolism and the loss of moisture in the form of evaporation from insects bodies which consumes up to 41.95% (41.2% for male insect, 42.7% for the female) of the total fish intake by insects (Hiratsuka, 1920; Waldbauer, 1968). These estimations are tabulated in Tables 8 to 13. According to these tables tremendous amount of dried fish meat is lost due to insect infestation. As seen in Figures 1 and 2 the weights of imported dried fish are constantly decreasing due to serious infestation from the beginning of storage. There must also have been weight loss before the dried fish arrived in Sri Lanka.

Table 8

Damage by insects during storage of imported catfish

Storage period (days)	Change of weight (g)	Weight (g)	Loss (%)	Estimated gross damage	
				(g)	(%)
0	575	-	-	-	-
13	480	95	16.5	237.5	41.3
37	460	115	20.0	287.5	50.0
42	440	135	23.5	337.5	58.7
47	435	140	24.3	350.0	60.9

Table 9

Damage by insects during storage of imported skipjack

Storage period (days)	Change of weight (g)	Weight (g)	Loss (%)	Estimated gross damage	
				(g)	(%)
0	505	-	-	-	-
13	480	25	5.0	62.5	12.4
37	455	50	9.9	125.0	26.04
42	445	60	11.9	150.0	29.7
47	440	65	12.9	162.5	32.2

Table 10

Damage by insects during storage of imported leatherskin

Storage period (days)	Change of weight (g)	Weight (g)	Loss (%)	Estimated gross damage	
				(g)	(%)
0	1 030	-	-	-	-
13	950	80	7.8	200.0	19.4
37	925	105	10.2	262.5	25.5
42	900	130	12.6	325.0	31.6
47	820	210	20.4	525.0	51.0

Table 11

Damage by insects during storage of imported shark

Storage period (days)	Change of weight (g)	Weight (g)	Loss (%)	Estimated gross damage	
				(g)	(%)
0	240	30	-	-	-
13	210	30	12.5	75.0	31.3
37	220	20	8.3	50.0	20.8
42	205	35	14.6	87.5	36.5
47	200	40	16.7	100.0	41.7

Table 12

Damage by insects during storage of local dried fish (catfish)

Storage period (days)	Change of weight (g)	Weight (g)	Loss (%)	Estimated gross damage	
				(g)	(%)
0	835	-	-	-	-
4	835	0	0	0	0
14	825	10	1.2	25	3.0
24	800	35	4.2	87.5	10.5
32	775				

Table 13

Damage by insects during storage of local dried fish (barracuda)

Storage period (days)	Change of weight (g)	Weight (g)	Loss (%)	Estimated gross damage	
				(g)	(%)
0	500	-	-	-	-
4	490	10	2	25	5.0
14	490	10	2	25	5.0
24	430	70	14	175	35.0
32	425				

For locally produced dried fish no infestation was observed at the beginning of storage. After three weeks only certain insects were observed on both catfish and barracuda, while the infestation on skate was nil. The weight of skate has been adversely increased unlike the other two species of dried fish. This is mainly because of the moisture intake which is a typical phenomenon of salted-dried fish which occurs during the initial period of storage after processing.

Table 14

Distribution of insects on dry fish during the storage period (in weeks)

Type of insect	Storage period						
	1	2	3	4	5	6	7
Dermestes adult		abundant →				wiped out →	
Dermestes larvae		abundant →				wiped out →	
Necrobia adult		less →				abundant →	
Necrobia larvae			less in numbers →			abundant →	
Tribolium spp.			NIL →			increase in No. →	

5. CONCLUSION

Although the storage experiment reported here was rather short it was clearly observed that 30-50% of imported dried fish are damaged by insects in the first fifty days of storage. This represents a great protein loss for the population of Sri Lanka.

Losses due to insect attack of locally produced dried fish are not so serious as to imports, since these are consumed relatively faster, but still there are signs of wastage.

The excess quantities of salt in the dried fish, controls its susceptibility to insects.

It may be too early to estimate the extent of country's wastage of dried fish by insect infestation by these limited date. Further comprehensive research work is to be continued.

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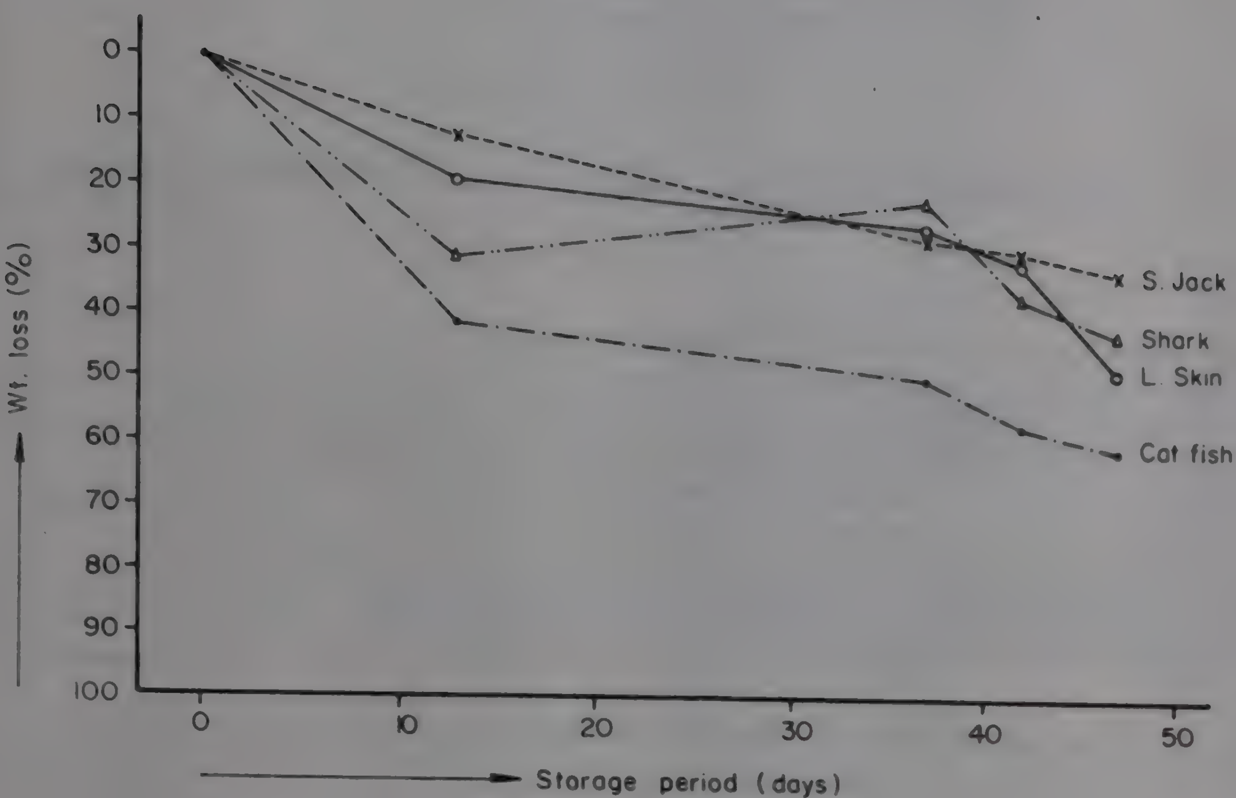

Fig. 1 DAMAGE OF IMPORTED DRIED FISH BY INSECTS

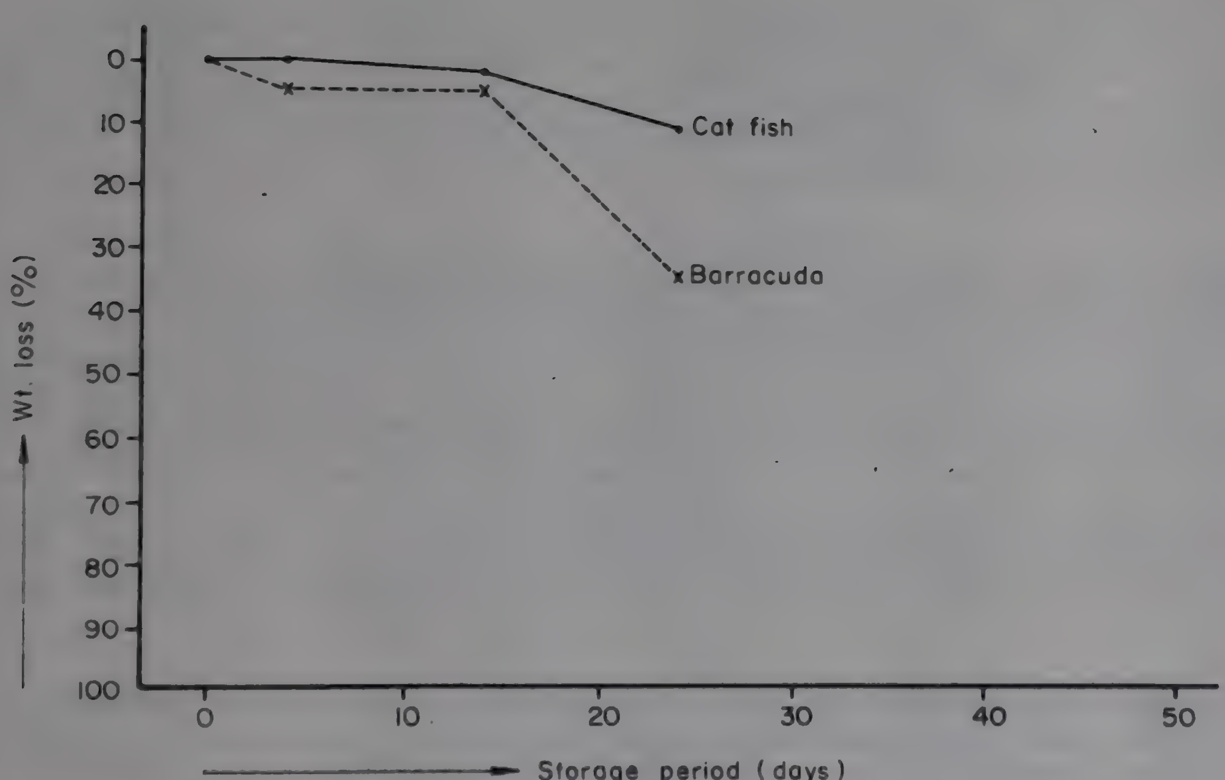

Fig. 2 DAMAGE OF LOCALLY PRODUCED DRIED FISH BY INSECTS

LOSSES OF TRADITIONALLY CURED FISH: A CASE STUDY

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ABSTRACT

The cured fish industry of Senegal is described and the major losses of cured fish identified. An experiment designed to assess the losses of smoked-dried sardine (methora) and braised-dried sardine (ketiakh) is described. Losses of dry matter for methora were 15.2 percent and for ketiakh 34.5 percent under simulated commercial conditions. Blow-fly infestation was the major cause of these losses. Generally, therefore, losses of cured small pelagic fish were found to be very high and a reduction of the present levels of losses would significantly increase the amount of cured fish available for human consumption.

INTRODUCTION

This paper is based on field and experimental work conducted in Senegal in June and July 1982. The work was conducted by the author in collaboration with the Fish and Storage Sections of the Institut de technologie alimentaire, Dakar, Senegal and is described in greater detail in an unpublished TPI Report (Wood, 1982). The background to this study and the considerations behind the methods used have been reviewed in some detail by FAO (1981), and the author strongly recommends this comprehensive review entitled "The Prevention of Losses in Cured Fish" to anyone interested in this very important area of work. The first part of the work took the form of a survey which identified the major problems of the cured fish industry, followed by an experiment aimed at assessing losses during particular processes. In this paper the findings of the survey will be outlined briefly and the loss assessment technique described in more detail as an example of how such work may be undertaken.

In Senegal, specific types of fish are processed in specific ways for specific markets. From information gained during the visit the generalizations shown in Table 1 can be made regarding major processing techniques and markets. The production levels of the major cured fish products is given in Table 2, with an indication of which areas are particularly important for the production of particular products. It must be noted that Thies is the major producing region and ketiakh the major product in terms of total annual production. There were marked seasonal variations in the level of catches, types of fish caught and hence products made at any given processing site. Also, different processing sites could process the same type of fish in different ways. The levels and causes of losses appeared to be markedly different from place to place and from product to product.

A summary of the causes and possible extents of losses of cured fish is given in Table 3. It must be noted that little information was gained on the degree of losses during distribution although *Dermestes* spp. infestation was common and a very obvious potential cause of high levels of losses for unsalted products. Losses during processing were more evident. It was very clear that the greatest problems were with the processing of small pelagic fish, with the products ketiakh and tambadiang suffering from heavy blow-fly infestations. Blow-flies were a problem with some of the other products (such as, guedj), but apparently to a much lesser extent. It must also be noted that the sardine season (and hence ketiakh and tambadiang production) at M'Bour and Joal, the major fishing centres in the Thies region, largely coincides with the wet season when losses

Table 1

Major cured fish products of Senegal

Product	Fish type	Processing method	Market
Fermented fish (guedj)	Mainly demersal species but also shark, rays and large mackerel	Fermented, split and dried	Senegal
Fermented shell fish (yete)	Large shell fish	Fermented, split and dried	Senegal
Dried oysters (yokhoss)	Oysters	Not observed during the visit	
Split, salted and dried fish (saly; salé-séché)	Sharks, rays, tuna	Heavy salting (often pickle curing) and drying	Export to West Africa
Salted and dried whole fish (tambadiang)	Small pelagic species	Light to medium salting (pickle cure) and drying	Senegal, especially eastern areas
Hot-smoked, smoke-dried fish chunks	Sharks, rays	Very hot smoking to cook and seal fish chunks followed by smoking to dry the fish	Export to West Africa
Smoked and dried fish (methora)	Small pelagic species, demersal species	Hot smoking to cook fish followed by smoke-drying and/or sun-drying. Large fish split, small fish processed intact	Export to West Africa and also consumed in Senegal
Braised and dried fish (ketiakh)	Small pelagic species	Smoked or more usually braised (charred), skinned and dried	Senegal, especially the central areas

Table 2

Production of cured fish products in Senegal, 1981

Product	Production (t)	Major production regions and their production (t)	
Guedj	3 496	Thies	1 961
		Sine-Saloum	640
		(Cape Verde, Fleuve and Casamance also significant producers)	
Yokhoss	2 208	Thies	2 208
Saly	309	Thies	201
Salé-Séché	219	Fleuve	198
Tambadiang	882	Sine-Saloum	717
Methora	680	Thies	388
		(Fleuve and Casamance also significant producers)	
Ketiakh	7 047	Thies	6 649
Total cured fish	17 765	Thies (total)	13 975

Source: République du Sénégal, 1982

Table 3

Summary table of the causes and possible extents of losses of the principal cured fish products in the areas visited in Senegal, June-July 1982

Product	Northern region (Fleuve)	Central region (Thies)	Southern/central regions (Thies)	
	St Louis and Gandiole (mainly dry)	Kayar (mainly dry during fishing season)	M'Bour (wet during sardine season, otherwise dry)	Joal (wet during sardine season, otherwise dry)
Guedj	BF - low D - unknown	BF - low D - unknown	a/	a/
Salé-séché	M - unknown	M - unknown	b/	b/
Tambadiang	b/	b/	a/	BF - high D - unknown
Hot-smoked	b/	b/	F - low BF - moderate/ low D - unknown M - unknown	
Methora	b/	b/	a/	a/
Ketiakh	b/	b/	F - high BF - high D - unknown M - unknown	

Cause of losses

F - Fragmentation
BF - Blow-fly (larvae)
D - *Dermestes* spp.
M - Micro-organisms (bacteria and moulds)

a/ Little production at the time of visit
b/ No production at the time of visit

NB: Possible causes of losses which did not appear to be a problem or potential problem, for particular products at particular locations have been excluded from the table

due to blow-fly infestation can be expected to be particularly high (FAO, 1981). Also, southern Senegal, which was not visited, has a much wetter climate than the areas which were visited and hence losses of cured fish as a proportion of production will probably be greater here than in the places studied.

A six-day field trial was conducted at M'Balling near M'Bour to assess the level of losses from catching to distribution, including a short storage period (as storage periods appeared to be generally short at that time of the year). Tambadiang was not produced at this site and so only ketiakh (braised, skinned and dried sardine) and methora (smoked, dried sardine) production were investigated.

MATERIALS AND METHODS

Materials and Processing Procedures

These fish bought for processing were predominantly *Sardinella aurita* (*S. aurita* only were processed, the other species being removed). They were bought in the afternoon of 12 July from the M'Bour landing area and were in a fresh condition. A sample of 30 fish were measured and weighed, the average length being 248.7 ± 25.8 mm (range 200-285 mm) and the average weight was 133 g. As no analytical facilities were available at the experimental site, a small second sample of fish were purchased on 16 July and kept on ice for

. day until it was possible to analyse them. The batch consisted solely of *S. aurita*, had ı length of 241.5 ± 12.3 mm (range 215-265 mm) and an average weight of 140.7 g. Their omposition was assumed to be the same as that of the original batch.

All processing and packaging was performed by the processors at M'Balling using their ısual techniques, materials and equipment. Processing started in the late afternoon and he fish left to cook overnight. Ketiakh was charred on the ground in the traditional way ut the smoked fish was prepared in an enclosed kiln. By the next morning the fires had urnt out and the fish had cooled. The ketiakh was collected from the ground and the skin, ead and tail removed by hand. Some solid salt was sprinkled over the fish before it was pread out to dry until the processors considered them to be sufficiently dry to be sale-ble ($1\frac{1}{2}$ days under the good drying conditions prevailing at this time) and packaged in he usual way, the smoked fish in cardboard boxes with sealed (taped) bottoms and the etiakh in gunny sacks.

The packaged fish was stored for three days in a weatherproof ventilated fish store, he packs resting on a cement floor. The ketiakh was then redried, heaped on a drying ack, repacked into the sack and stored in the same fish store. The redrying period was wo days and the total restorage period was five days.

oss Assessment Procedures

For the purposes of loss measurement, stratification of the processes was performed y dealing with each processing step as separately as was practically possible. The steps ere broadly similar for the two processes and are indicated in Table 4. As suggested by AO (1981), losses were viewed as a loss in the weight of nutrients and as a loss of income.

Table 4

Stratification of methora and ketiakh processing for loss assessment

Fresh fish in boat

LOSSES BEFORE PROCESSING

Fresh fish used for processing (t_0)

LOSSES DURING PROCESSING - COOKING

Cooked (smoked or charred) wet fish (t_1)

LOSSES DURING PROCESSING - DRYING

Dried fish at processing site (t_2)

LOSSES DURING STORAGE (1)

Dried fish about to be sold and consumed or reprocessed prior to further storage (t_3)

LOSSES DURING STORAGE (2)

Dried fish about to be sold and consumed (t_4)

At each processing step the fish was firstly inspected for quality. During processing only two qualities were identified, fish regarded as acceptable for the continuation of the process and fish not regarded as acceptable for this purpose. The fish was separated into these two categories and weighed on a platform-type balance. A sample of six fish was then taken from the acceptable fish for moisture content analysis. The acceptable fish were then reweighed.

In order to assess losses, consideration must be given as to what happens to the unacceptable fish. If it was potentially edible material which was discarded due to defects, such as being the wrong species, physically broken or mouldy, then the extent of loss was taken as the simple ratio of the weight of discards to the total weight of discards plus acceptable fish. In other cases, however, it was reprocessed to a different

product with no loss of nutrients but with a reduction in value, and hence an economic loss to the processor or trader. Similar considerations affected the final products suitable for retail sale although insufficient time was available to establish quality standards, except in the case of broken and unbroken ketiakh, where unbroken pieces were defined as those which would not pass through a sieve of mesh size 12.7 mm^2. Each case was considered on its individual merits.

Losses of nutrients from acceptable fish were calculated as indicated in FAO (1981), using the equation shown below (equation 2 of FAO, 1981):

$$\text{effective loss in fish} = \frac{W_1\ (100-M_1)}{100} - \frac{W_2\ (100-M_2)}{100}$$

where W_1 = weight of fish at time or step 1 (AFTER sampling for analysis), EXCLUDING the weight of discarded fish

M_1 = moisture content (% wet weight) at time or step 1

W_2 = weight of fish at time or step 2 (BEFORE sampling for analysis)

M_2 = moisture content (% wet weight) at time or step 2

Samples for moisture content analysis were minced thoroughly and duplicate representative sub-samples were analysed by the method described in FAO (1981). The composition of the various samples analysed as part of the loss assessment procedure is given in Table 5.

Table 5

The composition of fish samples analysed for loss assessment

Proportion of the major parts of the fresh fish (by weight)		Composition of flesh, skin, bone portion (% wet weight)		Moisture contents of samples taken during processing (% wet weight)		
				Time of sampling	Methora	Ketiakh
Flesh, skin, bone	64%	Moisture	75.50	t_o	75.5	75.5
Head, tail, guts	36%	Fat	0.95	t_1	25.0	-
		Protein	20.30	t_2	25.1	26.8
		Ash	1.71	t_3	29.4	33.1
				t_4	-	19.8

A satisfactory moisture content analysis of the ketiakh samples at t_1 could not be undertaken as the fish was too moist to ensure adequate preservation. To estimate the level of losses the amount of fish before and after each processing step was calculated on a dry weight basis (details of the calculation are given in FAO, 1981). In an attempt to simplify a rather complex experiment, no correction was made for the bone content of the fish which may have led to an underestimation of losses (see FAO, 1981). The salt content was taken to be negligible as the methora was unsalted and the ketiakh could not have taken up much salt during the salting procedure adopted.

Losses between each pair of adjacent steps were considered independently. The overall level of losses over the whole process was estimated by calculating the dry weight of fish which would be found at the finish of each step, starting at the first stage under consideration with 100 units of dry material.

RESULTS

Losses Before Processing

On 12 July 1982, the day the experimental processing started, losses of small pelagic fish before processing were low or negligible. About 5% (4.3% and 5.7% for two batches, see Table 6), of the weight of the fresh fish was not processed as it was damaged or of the wrong species. Although some of this may be discarded some would be fried and sold or eaten by the processors' families and hence little if any of this would count as a loss, as defined by FAO (1981).

Table 6

Losses before processing

Day	Sardine discarded into sea		Broken and non-sardine species not used for curing	
	Catch (%)	loss of fish for curing (%)	(%)	Loss (%)
11 July	up to 80	up to 100	-	-
12 July	0	0	4.3, 5.7	0
13 July	0	0	-	-
14 July	0	0	-	-
15 July	over 50	over 50	-	-
16 July	a/	a/	a/	a/

a/ Less than 50% of usual fishing effort

Note: It was said that some discarded fish was reclaimed by processors on the following day if the weather improved, but this practice was not observed during the time of the visit

On 11 July, however, it had rained during the late afternoon and early evening creating a massive disruption of ketiakh production. A local fisherman said that about 80% of the sardine catch was not sold and had to be discarded back into the sea. The long line of rotting sardines along the high-water mark was clear evidence that losses had been very high. The level of losses and the exact nature of the losses continued to vary depending on the weather (see Table 6).

Rain in the morning of 16 July kept most of the fishing boats inactive. Fishermen said that rain made fishing more difficult and the uncertainty regarding selling the fish meant that there was little incentive to go fishing during wet weather. Less than half of the boats went fishing, leading to a sharp drop in the supply of fish, and hence a drop in the production of ketiakh.

Losses During Processing

It can be seen from Table 7 that the data for the dry weight of fish at t_0 was inaccurate. Losses during cooking were, however, clearly due to physical destruction rather than any consumption of flesh by insects. For methora the potential loss was from fish falling into the fire, but this did not appear to happen. For ketiakh losses occurred as fish were broken during handling and charring. Broken pieces of muscle tissue were regarded as a loss of nutrient as this part of the fish was potentially available to the consumer but was used as a fertilizer. Due to breakage, 5.0% of muscle (expressed as a % of the total muscle tissue left after charring, intact plus broken pieces and excluding the weight of salt added), was lost. The weight of head, skin and gut material removed was not regarded as a loss, as this was an intrinsic part of the process. The relatively

low yields obtained for ketiakh did, however, have obvious financial implications as the products were sold on a weight basis.

Table 7

Losses during processing

	Methora		Ketiakh	
	Weight (kg)	Loss (%)	Weight (kg)	Loss (%)
Weight fish used for processing, t_0				
(wet weight)	126.80	-	122.30	-
(dry weight)	31.10	-	19.20 (flesh, skin, bone only)	-
Weight product put on drying racks, t_1				
(wet weight)	69.20	-	58.74 (including 1.0 kg salt)	-
(dry weight)	51.9	unknown	-	unknown
Broken pieces of muscle discarded after cooking (wet weight)	0.0	0.0	3.02	5.0
Skin, etc., removed (wet weight)	0.0	0.0	37.16	0.0
Weight product after drying, t_2				
(wet weight)	65.76	-	37.99	-
(dry weight)	49.30	5.0	27.80	unknown

During drying, blow-fly infestation was the major problem with both methora and ketiakh becoming infested. The problems with the ketiakh were very obvious as some larvae could be seen moving on the fish surface. On the outside the methora appeared to be insect free, but on examining three fish, one was found to be infested with blow-fly larvae. No inspection was made on the levels of infestation but quantitative estimation indicated that 5.0% of the flesh was lost (Table 7).

Losses During Storage

Blow-fly infestation continued to be the major problem during the initial three-day storage period. The methora also suffered from some mould attack, but *Dermestes* spp. infestation was not observed in either product at this stage. Mould attack resulted in the rejection of methora (4.1% of the product, see Table 8), but it was unclear whether the fish would be discarded or reprocessed to ketiakh. Additionally, 6.6% of the dry weight of the methora was lost, presumably due to blow-fly infestation; 18.1% of the dry weight of the ketiakh was lost. Large numbers of blow-fly larvae were present in the fish and there was little doubt that these were the cause of most or all of this loss.

The experiment with the methora ended at t_3 on the assumption that they would normally be consumed at this stage, but the ketiakh was redried and stored for seven days. During this stage, 15.8% of the dry weight was lost, probably due largely to continuing blow-fly infestation and the removal of larvae which had been present in the fish at t_3. At t_4, blow-fly infestation had completely ceased, but *Dermestes* spp. and *Necrobia rufipes* infestation had started.

Table 8

Losses during storage

	Methora		Ketiakh	
	Weight (kg)	Loss (%)	Weight (kg)	Loss (%)
Weight product used for storage expt. t_2				
(wet weight)	52.14	-	37.65	-
(dry weight)	39.10	-	27.60	-
Weight product after 3 days' storage at t_3				
(wet weight)	5.170	-	33.75	-
(dry weight)	36.50	6.6	22.60	18.1
Weight fish rejected for quality reasons at t_3	2.10	4.1	0.0	0.0
Weight fish reprocessed at t_3				
(wet weight)	-	-	33.59	-
(dry weight)	-	-	22.50	-
Weight reprocessed stored fish, 4 days after t_3 (t_4)				
(wet weight)	-	-	23.62	-
(dry weight)	-	-	18.94	15.8
Weight intact fish and large fragments				
(wet weight)	-	-	17.72	-
Weight and % fine fragments				
(wet weight)	-	-	6.13	25.9 (economic loss of about 13%)

The low number of larvae and the short period of beetle infestation seemed to indicate that losses due to this infestation were probably low at t_4.

A further loss was due to fragmentation of the fish. Ketiakh fragments were sold at about half the price of intact pieces, so as 25.9% of the weight of the final product were fragments, there would have been a loss in financial value of about 13%.

Overall Level of Losses

These are shown in Table 9 in terms of the loss in dry matter and the national financial loss to the industry as a whole.

Significance of the Losses of Cured Fish Products in Senegal

In order to assess the significance of the losses of cured fish, it would be helpful to derive an overall "average" figure for the level of losses. In the specific situations encountered actual losses varied between 0% (for example in salted dried shark prepared at St. Louis) to possibly 100% (for sardine discarded during wet weather at M'Bour). Hence, as was emphasized in FAO (1981), "average" or "typical" figures for levels of losses are

of little value in selecting appropriate countermeasures. Nevertheless, a number of assumptions can be made in order to derive figures which indicate the significance of these losses.

Table 9

Overall level of losses

Processing stage (see Table 7)	Methora		Ketiakh	
	Quantity of fish (dry weight basis t_o = 100)	Loss (%)	Quantity of fish (dry weight basis t_o = 100)	Loss (%)
Fresh fish in boat	100		100	
LOSSES - DISCARDS		0		0-100
Fresh fish for processing (t_o)	100		0-100 (take as 100 for further stages)	
LOSSES PHYSICAL - DESTRUCTION		unknown (probably 0)		5.0
Cooked, wet fish (t_1)	100		95	
LOSSES - BLOW-FLIES		5.0		unknown
Dried fish at processing site (t_2)	95		95	
LOSSES DURING STORAGE (1) - MOULDS - BLOW-FLIES		4.1 6.6		0 18.1
Dried fish (t_3)	84.8		77.8	
LOSSES DURING STORAGE (2) - BLOW-FLIES AND BEETLES		-		15.8
Dried fish (t_4)	-		65.5	
Overall loss of dry matter		15.2		34.5
Economic loss during marketing		0		13.0
Overall economic loss (assuming lost fish sold at usual prices)		15.2		43.0

In the case of ketiakh production in Thies region, the annual loss was estimated at 41.5% on a dry-matter basis and 49.1% on a financial basis (see Table 10). From the data presented in Table 2 it can be seen that the Thies region produced 78.7% of the cured fish prepared in Senegal in 1981 and that ketiakh produced in Thies alone accounted for 37.4% of the total cured fish production in that year. In 1981, 2 760 t of ketiakh, at an approximate value of CFA.F. 600 million (about £.Stg. 1 million) may have been lost.

Losses of ketiakh were examined in detail as they appeared to be particularly high. The overall annual losses for all cured fish will probably be lower than these levels. Assuming losses to average 25% (the assumed typical figure quoted in FAO, 1981), this would mean that the equivalent of about 12 500 t of wet fish with a value of about CFA.F. 915 million (about £.Stg. 1.5 million) were lost in 1981. Although these figures appear to indicate that losses of ketiakh account for two-thirds of the entire losses of the cured fish industry in Senegal, it would be wrong to neglect losses in the other products. These have not been studied in any detail and could be very high. The derived overall figures are almost certainly very inaccurate and could be highly misleading in this respect.

Table 10

Significance of losses of ketiakh occurring annually in the Thies region

(a) Before processing (i.e., fish discarded due to rain interfering with processing)
The approximately 4-month sardine season in the Thies region (June-September) coincides with the wet season. By its very nature it is difficult to give general figures due to losses of this kind, but the following assumptions will be made as an illustration. The assumptions are made on the basis of impressions gained during the work and are not based on established data.

1. Of the sardine used for ketiakh, 75% is caught during the wet season.
2. Ketiakh production is interrupted on an average of 2 days/week.
3. On average, 50% of the sardine available for ketiakh production is discarded when rain interrupts processing.

Hence $\frac{75}{100} \times \frac{2}{7} \times$ 50% of the sardine catch will be discarded

= 10.7% loss of nutrients and financial loss.

(b) During processing and distribution
Taking the values found experimentally as "average" for the commercial situation for losses of dry matter = 34.5%; financial losses = 43.0%

(c) Overall losses

Processing stage	Quantity of fish (Dry weight basis t_o = 100)	Quantity of fish (Financial value t_o = 100)	Loss in % (Of dry matter)	Loss in % (Financial)
Before processing	100	100		
"Average" losses			10.7	10.7
Start of processing	89.3	89.3		
"Average" losses			34.5	43.0
Fish for consumption	58.5	50.9		
"Average" overall losses			41.5	49.1

Although in terms of the national economy the direct financial losses are fairly low, this is because of the low market value of the products, which in turn reflects the low purchasing power of the consumers. The true significance of the losses is in their effect on the national diet. Senegalese cured fish is an important part of the diet in most of Senegal and many other West African countries. Effective loss prevention could also facilitate increased distribution of cured fish to remote areas where animal protein is most urgently needed but which is presently inhibited by problems, such as insect infestation.

DISCUSSION

Loss Assessment Methodology

It was emphasized by FAO (1981) that "loss assessment is required to discover where and how losses occur and to measure their extent, so that priority areas for loss reduction can be determined". The methodology must also be suitable for evaluating any countermeasures to losses and to demonstrate the value of appropriate countermeasures to the industry. In general, the jointly qualitative and quantitative approach adopted in this study appeared well suited to achieving all of these objectives, although some further refinement of the method is required.

The major difficulty was during the initial processing stage. Losses of fish which were discarded due to quality considerations (e.g., broken fish), could be quantified readily, but the measurement of moisture content of the fish at the start of processing is very difficult under field conditions.

The composition of the head-, gut- and tail-free sample analysed should have been similar to the composition of the parts of the fish used to prepare ketiakh. In practice, this was clearly not the case. The effect of keeping the analysed sample on ice or genuine composition differences between the fish processed and the fish analysed presumably caused these differences, although small differences would cause large errors in loss measurement (see example in Table 11). Whole fish were not analysed to give a better estimation of the losses during methora cooking because it was assumed these would be negligible (unless any fish fell into the fire).

Table 11

Effects of errors in the determination of the initial moisture content on the apparent level of losses during fish drying

	Actual situation	Situation (a)	Situation (b)
Initial wet weight	100.00	100.00	100.00
Dry weight (calculated)	28.00	30.00	26.00
Final wet weight	32.76	32.76	32.76
Dry weight	25.20	25.20	25.20
Apparent losses of dry matter (%)	10.00	16.00	0.03

Say that during the initial drying process losses are 10%, but the initial moisture content of the batch (actually 72%) is estimated at (a) 70% and (b) 74%, final moisture content is 30%

The net effect was that losses due to blow-fly infestation during the early processing stages may not have been assessed. Although not a problem with methora as they were almost certainly low, the losses of ketiakh may have been underestimated as heavy blow-fly infestation was apparent from a very early stage in drying.

Although this may seem to be a major problem, given that losses due to blow-flies can be very great during drying (FAO, 1981), in practice it may be possible to overcome it to a large extent. During the early drying stages, although infestation levels can be high, losses in dry matter will be low as the larvae stay in the fish and have probably consumed very little flesh over this period. Hence by weighing and analysing the fish half way through drying and at the end of drying (and after blow-fly infestation has ceased, if this time is different), a reasonable estimate should be obtained for the quantitative losses due to blow-fly infestation throughout the drying process.

During subsequent storage and reprocessing procedures the method used appeared to be highly satisfactory. Errors in moisture content are not so critical to the apparent level of losses (see Table 12), although they still are significant.

Table 12

Effects of errors in the determination of moisture content on the apparent level of losses during fish storage (and redrying)

	Actual situation	Situation (a)	Situation (b)
Initially, wet weight	100.00	100.00	100.00
Dry weight (calculated)	70.00	72.00	68.00
Finally, wet weight	75.60	75.60	75.60
Dry weight	63.00	63.00	63.00
Apparent losses of dry matter (%)	10.00	12.5	7.3

Say that the losses during storage are 10% but that the moisture content of the total batch (actually 30%) is estimated at (a) 28% and (b) 32%, final moisture content say 20%

Losses of Cured Sardine Products in Senegal

Losses of unsalted fish due to blow-fly larvae of the order 25-30% have been reported previously and it has been suggested that losses in the order 10-30% might be expected (FAO, 1981). In Senegal losses of this order (34.5% of dry matter) have been shown to occur during processing and a short storage period of the product ketiakh.

In addition to these losses, there was very considerable discarding of fish during wet weather before processing started. Also, the experiment was conducted under generally favourable conditions and using relatively good facilities. When rain interfered with processing very much higher losses could be expected due to heavier blow-fly infestations. In some cases these reached 100% when rain interrupted the charring stage and some (but by no means all) processors discarded their fish as they were not cooked. Other processors continued with the peeling and drying of the uncooked fish. By no means all the ketiakh on drying racks or mats was covered during rain. Processors sprinkled solid salt over the fish, but losses due to blow-fly infestation were almost certainly high.

The procedure of partially drying the ketiakh, storing in the hope of an early sale and redrying when blow-fly damage becomes serious appeared to be a fairly usual commercial practice. There was a clear incentive to keep the weight and hence value high by not drying the products sufficiently to prevent blow-fly damage. As heavy infestations of ketiakh were commonly observed in the commercial products the experiment described here can be regarded as reasonably representative of the current commercial situation.

The experiment with methora was perhaps not so typical as there are very few enclosed kilns in commercial use in Senegal. Although some fish was attacked by mould this would probably not be a usual problem. The processors said that the product was suitable for a short storage period only, for example for export by air freight but not sea freight. In commercial practice the processors were probably sufficiently aware of the need to dry fish adequately to prevent appreciable losses due to mould attack.

Losses of methora dry matter, presumably due to the observed blow-fly infestation, were considerably higher than expected (over 10%), as the product appeared to be very dry before spreading on the drying racks. It was, however, clear that the fish had been case-hardened during smoking. Flies were able to lay their eggs in the mouth of the fish and larvae could then penetrate the damp interior. It can be seen from Tables 5 and 7 that the fish did not dry during their time on the racks and actually started regaining moisture during storage. This was due to the inability of the interior moisture to penetrate the outer case-hardened "crust" and the tendency for this very dry outer layer to reabsorb atmospheric moisture.

CONCLUSIONS

The major losses of cured fish at the time of the visit occurred before and during the processing of small pelagic fish at the major centres of this fishery during this period, M'Bour and Joal.

Major losses occurred during wet weather when fish, which could not be processed, was discarded back into the sea. The major causes of losses during processing were blow-fly infestation and fragmentation (particularly with ketiakh). Under generally favourable conditions losses during ketiakh processing and storage were experimentally found to be 34.5% of the dry matter and 43.0% of the financial value. During methora processing and storage, losses of 15.2% of the dry matter were found experimentally. Wet weather generally increased the problems of processing and storage, and was said to lead to increased levels of insect infestation. *Dermestes* spp. infestation was probably a problem in the distribution of unsalted and lightly salted dried products but insufficient time was available to investigate this.

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STANDARDS FOR DRIED FISH

by

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ABSTRACT

Standards which set an orderly approach to a specific activity for the promotion of economy are based on the consolidated results of science, technology and experience to determine the progress not only for the present but also for the future development of each activity.

Malaysian Standards provide reasonable guidelines relating to the quality and process. This paper briefly describes the role of standards and the standardization mechanism involved in the formation of standards for dried fish.

INTRODUCTION

The technique of preserving fish by salting and drying has been used since civilization. It is simple and economical. Salting and drying is still the simple means of preserving fish in many developing countries.

In Peninsular Malaysia, about 7 993.77 t (132 137 pikuls) of dried-salted fish and 9 436.66 t (155 988 pikuls) of dried ikan bilis were produced in 1980[1/]. This made up about 10.6% and 12.5% respectively of the total processed fish. The estimated values amount to M.$ 40 million and M.$ 123 million respectively.

However, difficulties have been encountered by producers of dried-salted fish in developing countries, including problems of infestation, eating quality and poor shelf-life. There is still a need to upgrade and improve products so that they have a longer shelf-life, are made more attractive to consumer and are safe for consumption.

Dried-salted-fish remains a popular food and there will always be a demand for it. Thus it is necessary that quality should be maintained and improved. To achieve this, the Malaysian Standards so prepared set levels for the improved quality of this product. This paper briefly describes the preparation of the Malaysian Standards for dried salted fish, the various standards related to the subject and the procedure for compliance to these Malaysian Standards.

STANDARDS - THE INFRASTRUCTURE FOR TECHNOLOGICAL PROGRESS

The Standards and Industrial Research Institute of Malaysia (SIRIM), is the national body responsible for preparing and promulgating Malaysian Standards to provide industry, consumers and commerce with reasonable guidelines relating to the quality, safety and suitability of products and processes. Standards are prepared by "round the table" consensus by representatives from all interested parties such as industry, commerce, consumers and the Government and thus reflect the reasonable expectations of the consumer in relation to the product or process, taking into account the ability of the Malaysian manufacturer and processors to comply. Thus, Standards provide the guidelines towards improved manufacturing technology and products. Manufacturers, processors and industry are able to

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1/ Annual Fisheries Statistics, Malaysia, 1980

utilize Malaysian Standards in order to become more competitive and to meet the sophisticated expectations of local as well as overseas markets.

Malaysian Standards are generally for voluntary adoption by all interested parties and thus find their way into sales and technical transactions, contracts and agreements and are utilized by the Government Treasury in tenders and procurement and are quoted by responsible manufacturers to demonstrate the quality of their products or used in various educational programmes and activities, as well as to serve as a technical basis for communication.

SIRIM makes every attempt to ensure widespread use and application of Malaysian Standards, particularly when public health, welfare and safety are of consequence, and assists Government agencies in the adoption of standards, where appropriate, in legislation or Government regulation, to enhance public safety and protection.

DEVELOPMENT AND FORMULATION OF MALAYSIAN STANDARDS

The criteria for the formulation of Malaysian Standards are evaluated on a priority basis taking into account, among other things, the following considerations:

(a) consumer welfare including health, safety and environment,

(b) promotion of exports,

(c) maximum usage of locally available raw materials,

(d) promotion of high technology and skill-based industry,

(e) promotion of growth of rural and small-scale industries,

(f) contribution to overall national economy.

Since the process of development of a standard is both costly and time-consuming, proper planning and selection of standard projects are of extreme importance.

The proposal for a standard can arise from the needs of any sector of the economy. Requests are normally received from government ministries and departments; statutory bodies, professional and scientific bodies, manufacturers, universities, trade associations, consumer groups and sometimes even individuals. Subsequently the proposal is subject to scrutiny and priority evaluation. It is then submitted for consideration by the relevant Industry Standards Committee (ISC). In SIRIM, there are six ISCs, namely, Food and Agriculture, Chemical and Pharmaceutical, Consumer Products, Building and Civil Engineering, Electro-technical and Mechanical Engineering. Once the proposal is accepted by the relevant ISC, the work of standard formulation is assigned to the relevant Technical Committee (TC) under the ISC (new TCs may be created if the proposal does not come under the scope of existing TCs).

The TC comprises experts from various interested groups, namely governmental departments and agencies, manufacturers, consumers, educational institutions, professional and scientific bodies, etc., to ensure adequate representation of all view points. The TC may establish Technical Sub-Committees (TSC) and panels to do the actual formulation of the preliminary draft standard. Malaysian Standards for dried fish are formulated by the TC on Marine Foods which is under the authority of the Food and Agriculture ISC.

The preliminary draft is deliberated upon by the TSC/Panel/TC and comments are discussed objectively and resolved on the consensus principle, which is the mode of operation of the committee. The draft standard incorporating any revisions so made is then circulated widely to interested parties within the country and overseas national standards bodies. A period of three months is given for receipt of public comments. After this lapse of time any comments received are deliberated upon by the TC which then finalizes the draft standard. This final TC draft standard would then be submitted for consideration by the relevant ISC. The ISCs make final recommendations to the Standards Committee for the general adoption of the draft standard as a Malaysian Standard. (Figure 1 illustrates briefly the methodology of standards preparation so described for dried fish.)

The Malaysian Standard will be periodically reviewed to take account of new development and eliminate out-moded practices.

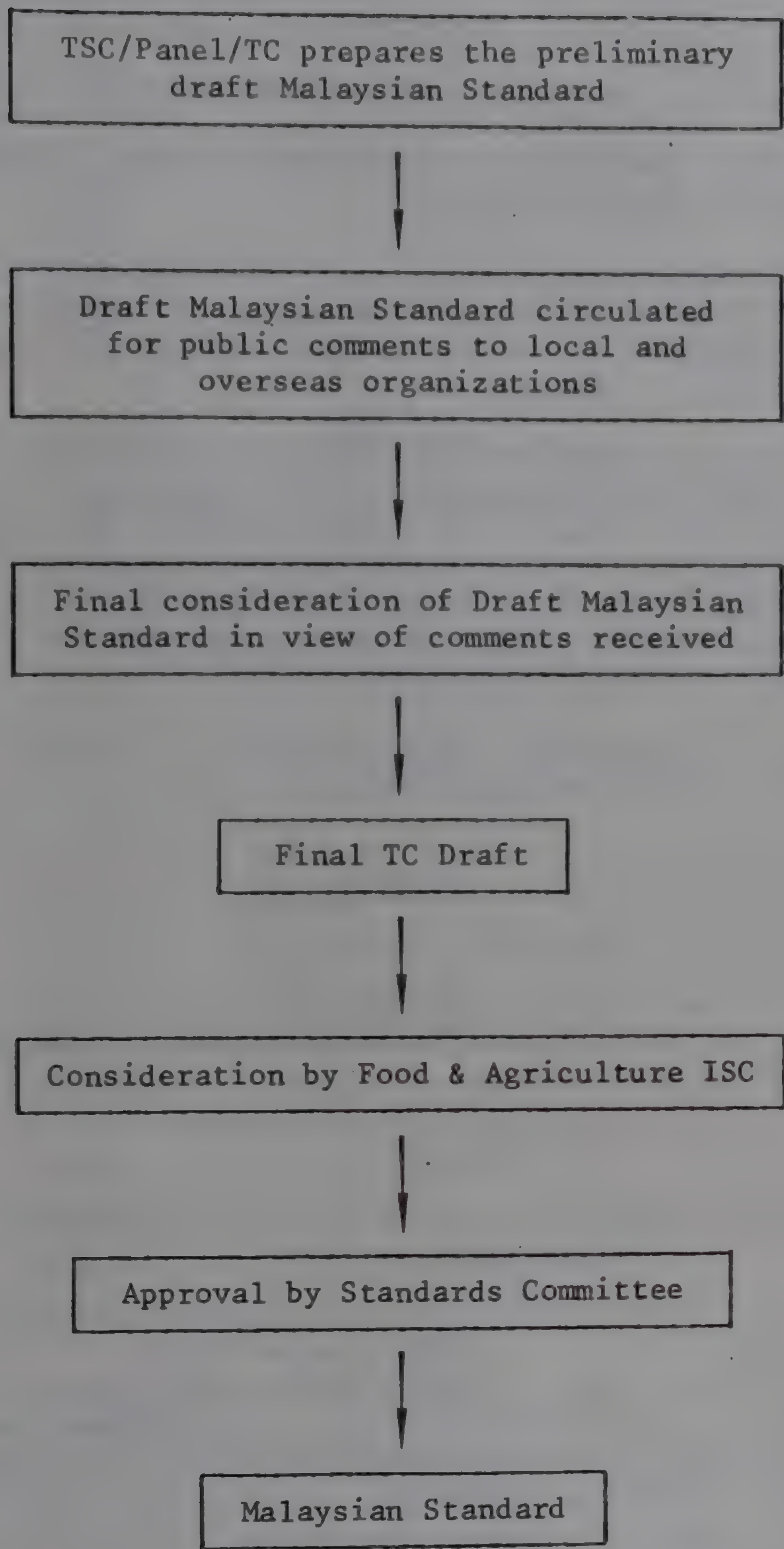

Figure 1 Methodology of Standards preparation for dried fish

This method of preparation offers the best assurance that standards genuinely represent all view points - that they are exactly adapted to national economic needs - and that they will be successfully adopted when published. The contributions by the qualified and experienced men are invaluable to the industrial development and technological progress on a national scale.

MALAYSIAN STANDARD SPECIFICATIONS FOR DRY SALTED FISH

There are five Malaysian Standards on dried fish that have been published by SIRIM. One Draft Malaysian Standard on this product is currently under preparation by the Technical Committee on Marine Foods. The Malaysian Standards on dried fish, as mentioned above, are listed as below:

(a) MS 299:1975 "Specification for Dry-Salted Ikan Talang (*Chorinemus* sp.)"

(b) MS 300:1975 "Specification for Dry-Salted Horse Mackerels (*Caranx* sp.)"

(c) MS 301:1975 "Specification for Dry-Salted Ikan Kurau (Threadfin)"

(d) MS 702:1981 "Specification for Dry-Salted Ikan Gelama (Jewfish)"

(e) MS 703:1981 "Specification for Dry-Salted Ikan Merah (*Lutianus* sp.)"

These Malaysian Standards specify the requirements for the raw materials, hygienic practices, preparation and the final products.

It is a condition that the fish before salting, be fresh, has no indication of any spoilage and shall be free from any visible contamination with soil or any other foreign matter. The fish shall be prepared by salting and drying; and the end product shall be free from fungal, insect and mite infestation.

In the preparation of the dried-salted fish hygienic practices plays an important factor in determining the quality of the products. The standards require that the fish shall be washed, eviscerated and cleaned. In salting of fish, the proportion of weight of salt to fish shall not be less than 1:4. The salted fish shall then be cured in tubs, cistern or other suitable containers for a suitable period, preferably not less than 24 h. The cured fish is then washed in self brine or clean water and dried under hygienic conditions either in the sun or in artificial dryers.

In order to conform to the above-mentioned standards, all dried fish products must meet the following analytical requirements. They are:

moisture	40% max
NaCl	25% min
Acid Insoluble Ash	1.5% max

Requirements for minimum salt content and maximum acid insoluble ash are on a moisture-free basis. However, each standard on dried-salted fish has its own grading system based on the physical presentation of the product.

Table 1

MS 299:1975 "Specification for Dry-Salted Ikan Talang (*Chorinemus* sp.)"

Designation	Weight in kg/katies	
	With heads	Without heads
Large	above 1.8 (above 3)	above 1.5 (above 2½)
Medium	0.6-1.8 (1-3)	0.5-1.5 (5/6-2½)
Small	below 0.6 (below 1)	below 0.5 (below 5/6)

Table 2

MS 300:1975 "Specification for Dry-Salted Horse Mackerels (*Caranx* sp.)"

Designation	Weight in g/katies
Large	above 80 (above 0.13)
Medium	50-80 (0.08-0.13)
Small	below 50 (below 0.08)

Table 3

MS 301:1975 "Specification for Dry-Salted Ikan Kurau (Threadfin)"

Designation	Weight in kg/katies
Large	above 5 (above 8)
Medium	3-5 (5-8)
Small	below 3 (below 5)

Table 4

MS 702:1981 "Specification for Dry-Salted Ikan Gelama (Jewfish)"

Designation	Weight in g/katies
Large	100 and above (0.17)
Small	40-99 (0.07-0.16)

Table 5

MS 703:1981 "Specification for Dry-Salted Ikan Merah (*Lutianus* sp.)"

Designation	Weight in kg/katies, whole/split
Large	0.9 and above (1.5)
Medium	0.6-0.8 (1.0-1.4)
Small	0.5 and below (0.9)

Other requirements, as specified by the Standards, are packing and marking of the products. Packing of dried-salted fish shall be in any suitable manner as agreed upon between the purchaser and the vendor. Suitable packaging containers include polyethylene bags, wooden cases and paper cartons. The containers shall be marked or labelled with name, type and grade of material; name and address of the vendor or recognized trade-mark, if any; lot number in code; and net weight and/or gross weight where applicable in metric units and in katies. Consequently, each container may, by arrangement with SIRIM, also be marked with the Standard Mark. This is done only after compliance with all requirements specified in the appropriate standards.

Apart from the above standard, a Draft Malaysian Standard on ikan bilis is currently under preparation. Ikan bilis, also known as anchovies, are very common in Malaysia waters and a sizeable quantity of the species are dried and consumed locally. The Draft stipulates a standard method of grading of ikan bilis as the existing grading system varies with different regions, processors and even wholesalers.

A panel on grading of ikan bilis comprises members from MARDI, Jabatan Perikanan, MAJUIKAN and SIRIM was set up under this technical committee. Discussions held between the panel and the processors and wholesalers of ikan bilis, resulted in a proposal for a standard grading system for use throughout Malaysia.

Currently, the grading of ikan bilis among the processors and the wholesalers is based generally on size, species and state of dryness. According to the producers and wholesalers, species do not play a very important role and mixed species can be placed

under the same grade if the characteristics are similar. The fish are first classified into various sizes, i.e., big, medium and small, and are then graded according to colour, odour and breakage.

It was brought to light during the preparation of the preliminary Draft Standard that there are differences in the grading system of ikan bilis between the producers/processors and the wholesalers; and those between the east coast and the west coast of Peninsular Malaysia. A batch of ikan bilis graded before sending to various distribution centres by the producers would then be regraded by the wholesalers. The regrading is done because of the change of quality during storage and transportation. Likewise, the difference in grade between the east coast and the west coast is due to the difference in sizes of this fish caught at these places.

Thus, for the benefit of all producers/processors, wholesalers and the consumer, it is the intention of the panel, set up under the Technical Committee on Marine Foods in SIRIM, to prepare a national standard for grading of ikan bilis in order to overcome the above differences.

The proposed criteria for the grading of ikan bilis are size, extent of breakage, colour, odour and texture. The whole ikan bilis, including the head, is considered in determining the size. A size of greater than 6.5 cm is classified as big, from 4.5 cm to 6.5 cm as medium, and less than 4.5 cm as small. The grade is then subdivided into grade A, grade B and grade C (see Table 6). For grade A ikan bilis, there shall be less than 5% breakage, whitish or yellowish colour (characteristic of the variety), no foul smell, dry and firm texture. Grade B shall be 5-10% breakage, darker colour, detectable foul smell and less firm. Finally, grade C shall be greater than 10% breakage, dark greyish colour with significant foul smell and moist. Before the product is accepted into the various grading listed above, the product is required to meet the following analytical requirement: the product shall not have more than 30% (w/w) moisture, less than 10% NaCl and more than 1.5% acid insoluble ash. In addition, the Draft described the preparation, packing and marking of the product. Sampling and testing procedures are included for easy reference.

Table 6

Proposed grade for ikan bilis

Characteristics	Grade		
	A	B	C
Breakage	less than 5%	5-10%	greater than 10%
Colour	whitish or yellowish	darker	dark greyish
Odour	no foul smell	detectable foul smell	significant foul smell
Texture	dry and firm	dry and less firm	moist

Incidently, this Draft Standard on ikan bilis is still under active consideration by the Technical Committee, thus it is liable to alteration. However, as standards are dynamic documents, even after this Draft is declared a Malaysian Standard, it is subjected to review from time to time, taking into consideration deficiencies in the standard which may surface while in use and also technological advances that may occur in this field.

SIRIM'S CERTIFICATION MARKS

What is certification? It may be defined as the action of certifying that a product or service has been produced in a manner to ensure conformity with specific standards or technical specifications. Once we have certified that the product or service is in conformity, the next natural step to take is to have some means of identifying certification. This may be achieved by the use of a Certification Mark or the issuance of a Certificate of Conformity.

SIRIM's Certification Marking Schemes offer independent third-party assurance that products are manufactured according to standards and under approved schemes of supervision and control, inspection and testing. SIRIM operates three types of Certification Marking Schemes:

(a) a licence for the use of the SIRIM Standard Mark is awarded to a manufacturer producing goods complying with a Malaysian Standard,

(b) a certificate of conformity for the use of the Mark of Conformity is awarded to a manufacturer producing goods complying with a recognized foreign National or International Standard,

(c) a licence for the use of the Safety Mark is awarded to a manufacturer producing goods complying with a Safety Standard.

In the case of dried-salted fish, SIRIM's Standard Mark is applicable to the standards mentioned earlier. Similarly, this scheme will also be applicable to ikan bilis when the Draft is approved as a Malaysian Standard.

Under these schemes, the producers/processors or manufacturer must comply with the scheme of supervision and control which spells out the requirements in quality control, sampling, routine testing, keeping of records and marking to denote compliance to the standard. A brief outline of the procedure to obtain a licence is as shown in the Appendix.

6. CONCLUSION

In conclusion, it has to be stressed that the producers/processors and the wholesaler of salted fish have an important role to play. Although several standards are already available, there is no legislation enforcing the mandatory use of these standards. The initial step has to be taken by the producers/processors or wholesalers. Quality conscious producers/processors or wholesalers should take it upon themselves to ensure that their products comply with the requirement in the Malaysian Standard so as to ensure that quality products reach the consumers.

High quality products do not necessarily mean costlier products. Only some amount of effort is needed on the part of the producers/processors and wholesalers to obtain the level of quality required. Quality products assure demand and have market potential locally and internationally. They also edge out sub-standard products.

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APPENDIX

PROCEDURE TO OBTAIN A LICENCE FOR THE USE OF THE STANDARD MARK

A Licence for the use of the Standard Mark is awarded to a manufacturer producing goods complying with a Malaysian Standard. The Standard Mark on the product implies compliance of the product with the relevant Standard and that the product is manufactured under a scheme of supervision and control, inspection and testing.

APPLICATION	Application on prescribed form accompanied by the Pre-licence Fee is made to SIRIM.
↓	
PRE-LICENCE PRODUCT TYPE TESTING	Sample of the product is tested for compliance with the Standard.* An inspection of the factory is made if the test results are satisfactory. If the product does not comply with the Standard, re-tests are carried out, after product development.
↓	
PRE-LICENCE FACTORY INSPECTION	The manufacturer is required to complete and return the Initial Factory Assessment Form so that a Pre-licence Inspection of the factory can be made. This inspection is to determine the manufacturing process, quality control and testing facilities of the factory, and to enable SIRIM to devise a Scheme of Supervision and Control for the product as required by the Standard Mark Licensing Rules for the issue of a Standard Mark Licence.
↓	
FURTHER PRE-LICENCE TYPE TESTINGS	The products are tested further to check the consistency of compliance with the Standard, and to establish the capability of the manufacturer to produce the goods to the required Standard consistently.

*If the testing cannot be carried out in SIRIM and has to be performed outside, either in Maslaysia or overseas, the applicant has to be responsible for expenses incurred in these initial tests, and for such testing as required under the terms and conditions of the Licence.

(continued)

APPENDIX (continued)

SCHEME OF SUPERVISION AND CONTROL

The manufacturer must comply with the Scheme of Supervision and Control for the manufacture of the product concerned. The Scheme spells out the requirements in quality control, sampling, routine testing, keeping of records and marking to denote compliance to Standard.

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AWARD OF LICENCE

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PHYSICS OF DRYING

by

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ABSTRACT

A mathematical treatment of the drying process is reviewed briefly and the engineering approach to the analysis of drying phenomena is outlined. Emphasis is placed on the description of the transport equations for heat and mass transfer and the formulation of mathematical models of drying operations. An illustration of fish drying by heated air is elucidated by comparison of drying plots and analytical predictions. It is concluded that knowledge of the drying process is still very limited and much theoretical as well as experimental work remains to be done.

NOMENCLATURE

- a constant depending on geometry of product
- D diffusion coefficient or diffusivity
- d thickness of slab
- H humidity
- h heat transfer coefficient
- k mass transfer coefficient
- L latent heat of vaporization
- Q rate of heat transfer
- T temperature of absolute temperature
- t time
- W moisture content on dry basis
- w weight

Greek letters

- ∂ bulk density of solids
- ε emissivity of surface
- σ the Stephan-Boltzman constant
- ∇ Hamilton's operator

Subscripts

- a ambient condition
- c critical point
- e equilibrium point
- r radiating surface
- s drying surface

INTRODUCTION

Although dehydration is one of the oldest methods for preservation of foodstuffs, man has applied artificial dehydration of foods for only about two centuries. By artificial dehydration, it is meant that an alternative source of heat is employed to take the place of direct exposure to the sun.

There are now several methods available to artificially dry food but air drying or drying by heated air has been proved to be the most economical. It follows that air drying has found its most extensive use in the food industry and that further improvement of the air drying process is necessary if further growth of the dehydration industry is to be expected.

The objective of drying analysis is always related to the prediction of drying times (Charm, 1978). The drying rate is established under various conditions prior to designing the plant in order to obtain reliable correlations for scale-up purposes. With heat and mass transfer studies, it is also possible to establish the mechanism of the drying process. Such data is essential since it facilitates the establishment of the rate-determining stage and consequently the improvement of the drying time by appropriate modifications. In other words, the prediction of drying time is used as the most fundamental datum in process design and in optimization of a drying plant.

DEVELOPMENT OF MODEL

To develop the mathematical equations that represent the drying behaviour of foods, a physical model is required. The most usual case is drying of a wet piece of food by heated air which is flowing parallel to the drying surface.

The simplest approach is to consider the piece of food as a slab which consists of the drying surface and the solid interior (Figure 1). The drying surface will be assumed to behave as an evaporating pool of water while the solid interior of the food will contain both free and bound water. Over this slab the drying air is blown, the conditions of which are constant, viz. its temperature and its relative humidity. Between the food and the air lies the stagnant air film which is the laminar boundary layer through which diffusion or mass transport of water can occur under the influence of a concentration difference.

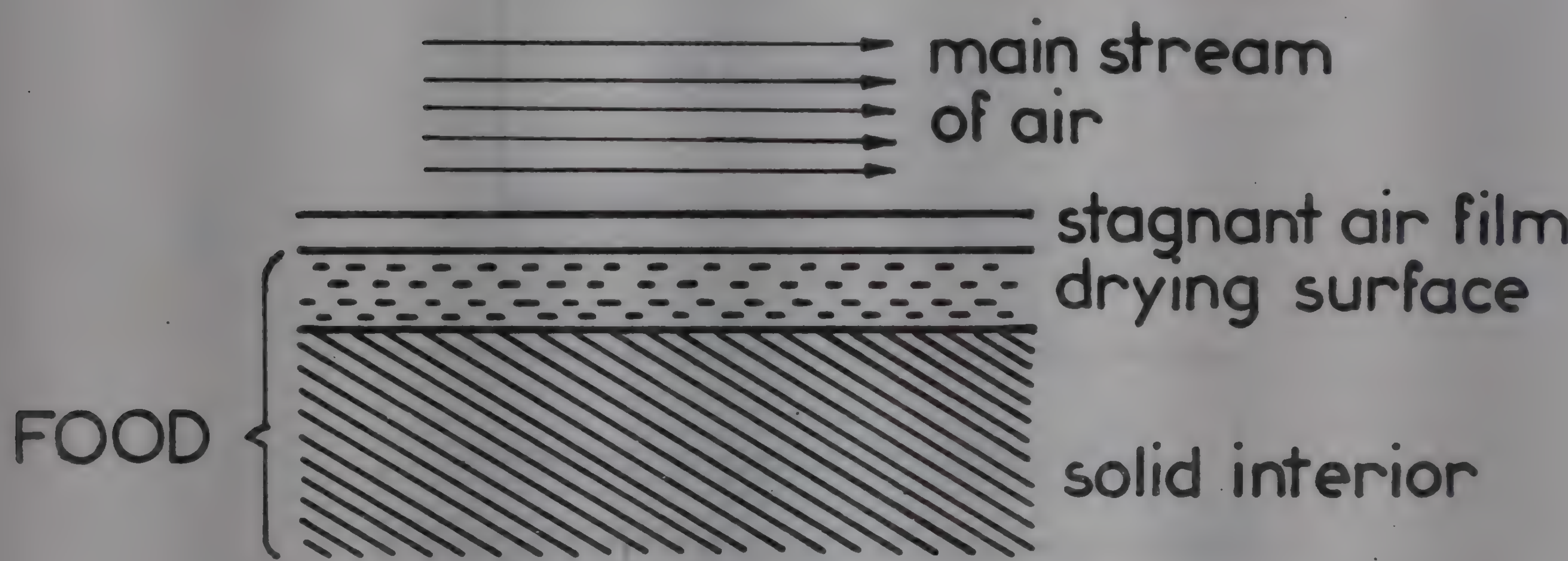


Figure 1

The physical model may also be represented in a block diagram (Figure 2). The drying air serves two purposes: as a heat source, it supplies the necessary latent heat of vaporization to the moisture in the food, and as a moisture sink, it acts as a carrier for removal of water vapour formed from the evaporating surface. Air drying is a simultaneous heat and mass transfer phenomena which depends on both internal as well as external conditions. The quantitative application of combined heat and mass transfer relationships to dehydration, however, is an engineering subject of considerable complexity that goes beyond the scope of this paper.

Finally, it is also desirable to establish the manner by which water is being transported from the solid interior to the drying surface as drying proceeds (Figure 3). Before moisture can be carried away in the air stream, it must first get to the surface of the solid. A number of moisture transport mechanisms through the solid have been proposed, but among these only liquid diffusion and flow of moisture due to capillary forces have received considerable attention and have been treated extensively in the literature.

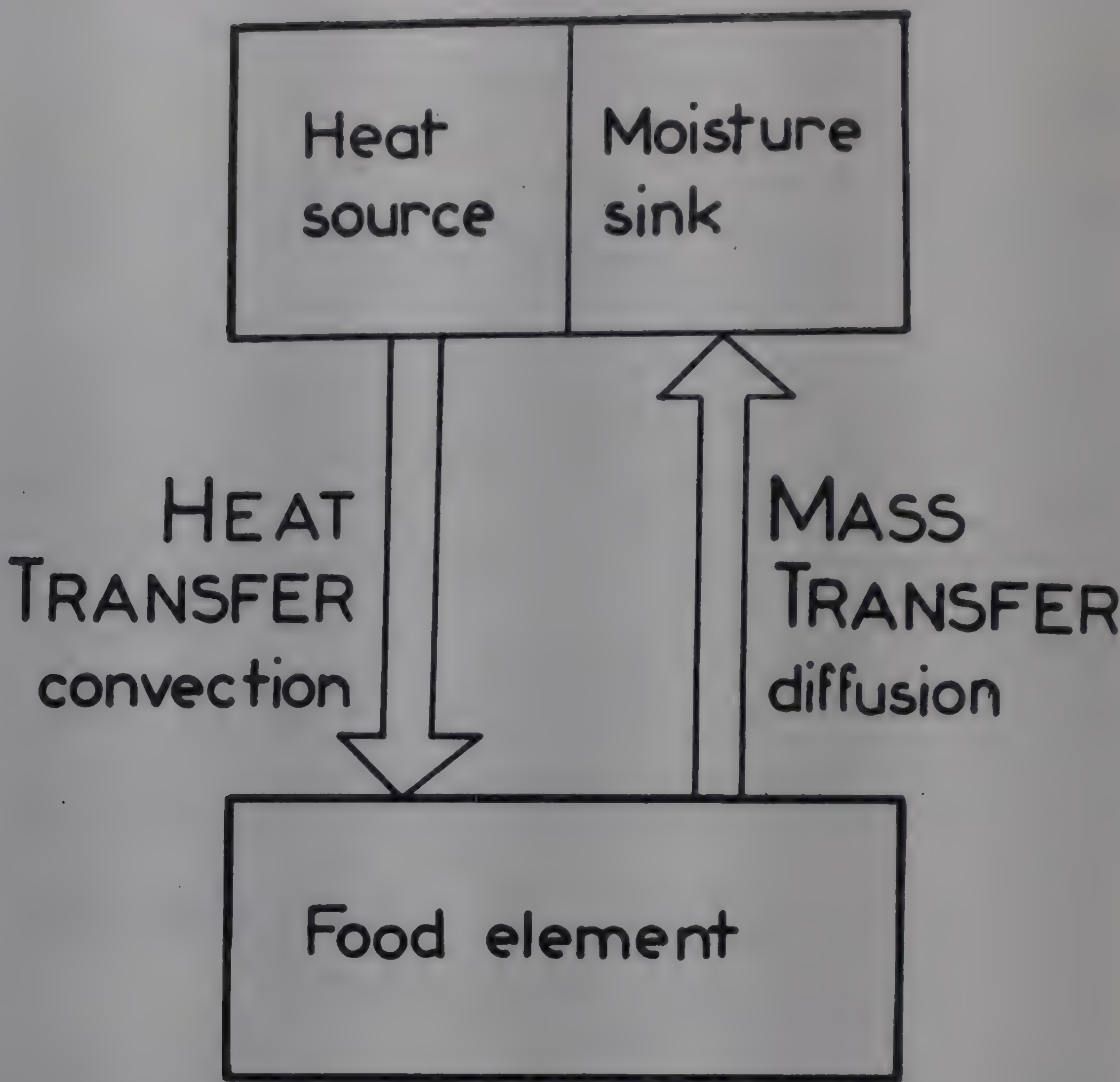


Figure 2

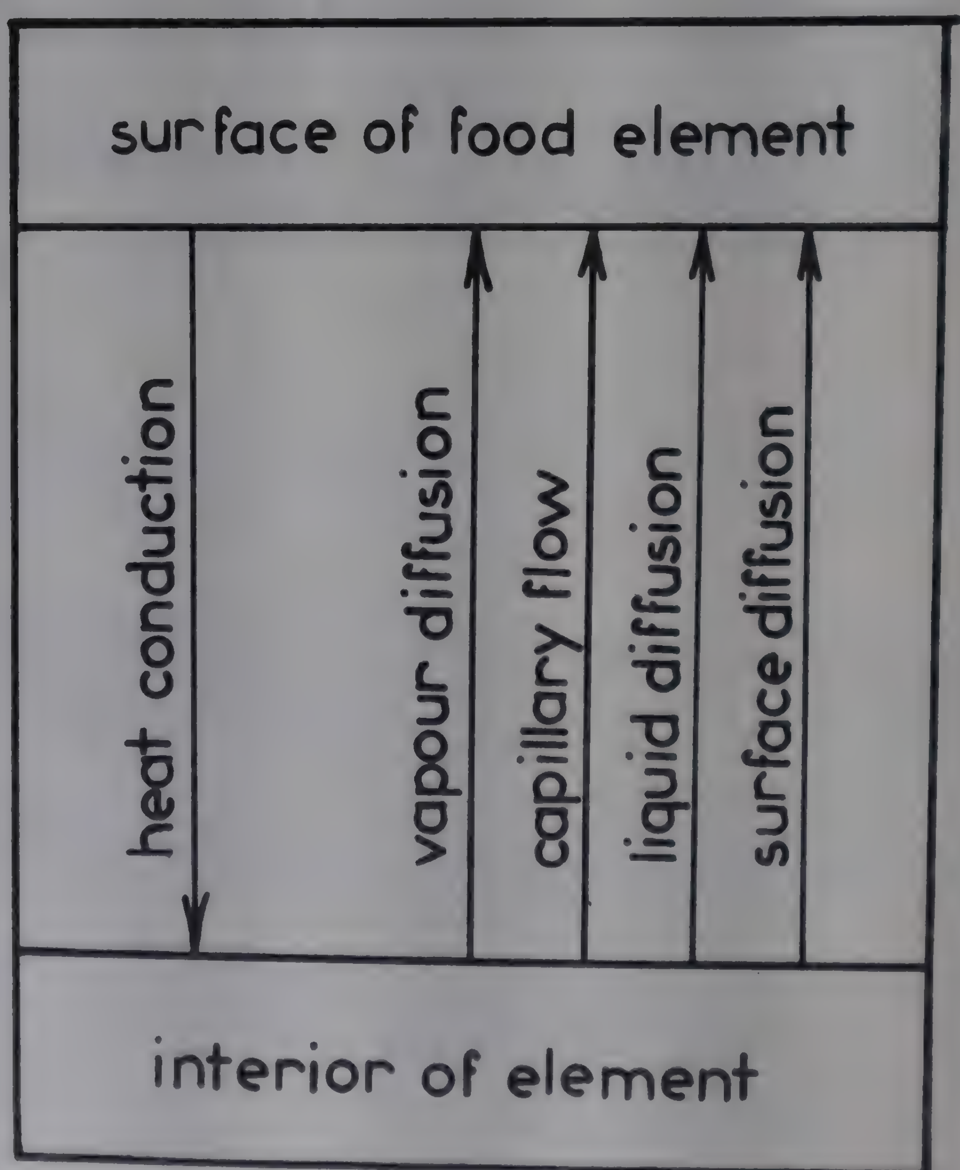


Figure 3

It is obvious the type of mechanism for moisture movement in solids depends on the food material to be dried. Generally, food can be classified into either gel-like, colloidal substances or porous materials. It becomes apparent that fish would be considered under the first classification. The manner by which water moves in solids is of special interest to drying analysis since it determines the analytical procedures to be adopted.

DRYING CURVES

In carrying out prediction of drying times, a very useful tool is the drying curve. There are several ways of expressing the drying process on a graph, one of which is to plot either the loss of weight of sample against time of drying or the moisture loss of sample on dry basis against time (Figures 4a and 4b). Both graphs are identical because there is a simple linear relationship between the weight and moisture content by definition. From the graph of moisture content versus time, it is possible to calculate the gradients at various points along the curve and plot these values against drying time. Such a graph is referred to as the drying rate curve (Figure 5).

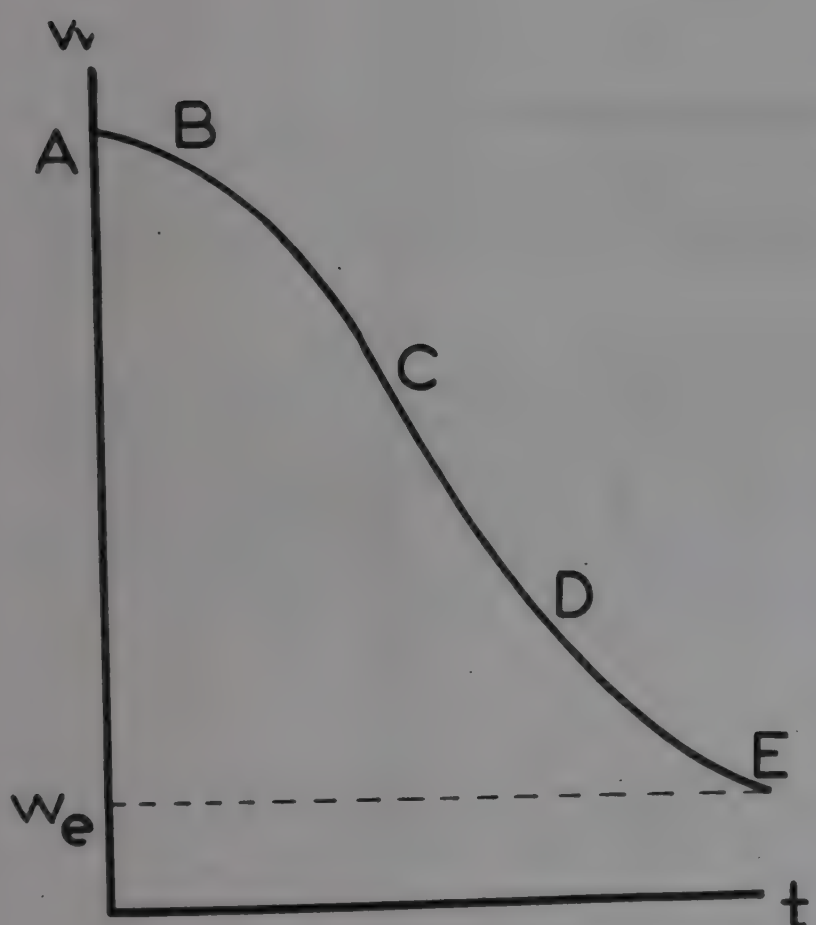


Figure 4 a

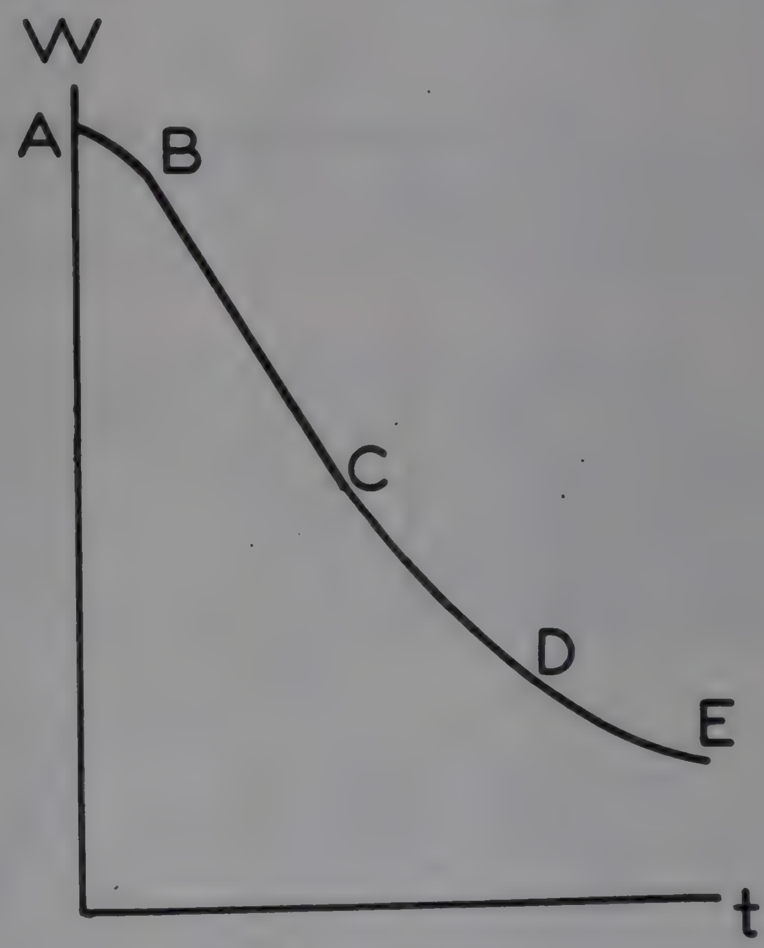


Figure 4 b

This drying rate curve is very useful for illustrating what happens as drying process takes place. The drying of a food material, as depicted in our physical model, can be divided into two distinct periods: (i) period B-C, the constant-rate period, so-called because the drying rate does not change with time, and (ii) period C-E, the falling-rate period during which the rate of drying decreases with time. The falling-rate period itself can be sub-divided into two different zones, namely periods C-D and D-E, and are known respectively as the first falling-rate phase and the second falling-rate phase.

In the constant-rate period the rate of mass transfer must be equal to the rate of heat transfer, otherwise the temperature of the drying surface will not remain constant. This situation is akin to that of the wet bulb temperature where the resistance to heat and mass transfer is located solely in the air stream, and because in our idealized model the conditions of the air are constant it follows that this resistance does not change with time. The resistances are represented respectively by the mass transfer coefficient, k, and the heat transfer coefficient, h, in the equations for mass and heat transfer:

$$\frac{dw}{dt} = K\,A\,(H_s - H_a)$$

$$\frac{dQ}{dt} = h\,A\,(T_a - T_s)$$

By equating these equations and after accounting for the latent heat of vaporization, we obtain by simple integration:

$$t = \frac{\partial\,d\,L}{h}\;\frac{\Delta W}{\Delta T}$$

The rate-controlling factors for predicting the drying time in the constant-rate period are, therefore, the drying surface area, the air temperature difference, and the heat transfer coefficient. The latter itself is dependent on the velocity of the drying air. It is concluded that the constant-rate period of drying is determined by external factors only.

As moisture continues to be removed, the constant-rate period changes into the falling-rate phase in which the drying rate decreases with decrease in moisture content (Figure 6). This point is reached when the moisture flow to the surface is no longer equal to the rate of evaporation and is often described as the critical moisture content. For fish, which is a single-phase gel-like material, it is assumed that moisture is transported within the solid by the mechanism of liquid diffusion. Thus if the moisture concentration gradient is the driving force, the diffusion equation may be derived in a manner similar to that by which Fourier's equation is obtained in heat conduction:

$$\frac{\partial W}{\partial t} = D\,\nabla^2 W$$

The limitations in the application of this equation are fistly the diffusion coefficient, D, has been assumed to be constant. Experimental observations show discrepancy from theoretical predictions occurring in the latter part of the falling-rate period which suggests that D cannot be treated as a constant. Secondly, it has been assumed that the system is a fixed volume. It is well-known that food, including fish, undergo considerable shrinkage during drying. The critical nature of these forces has led to other various expressions in more rigorous mathematical treatment.

The solution of the diffusion equation is a solution for partial differential equation and is given by :

$$\frac{W - W_e}{W_c - W_e} = \frac{8}{\pi^2} \sum_{n=0}^{\infty} \frac{1}{(2n+1)^2} \exp\left[-(2n+1)^2 \frac{\pi^2 Dt}{d^2}\right]$$

Figure 5.

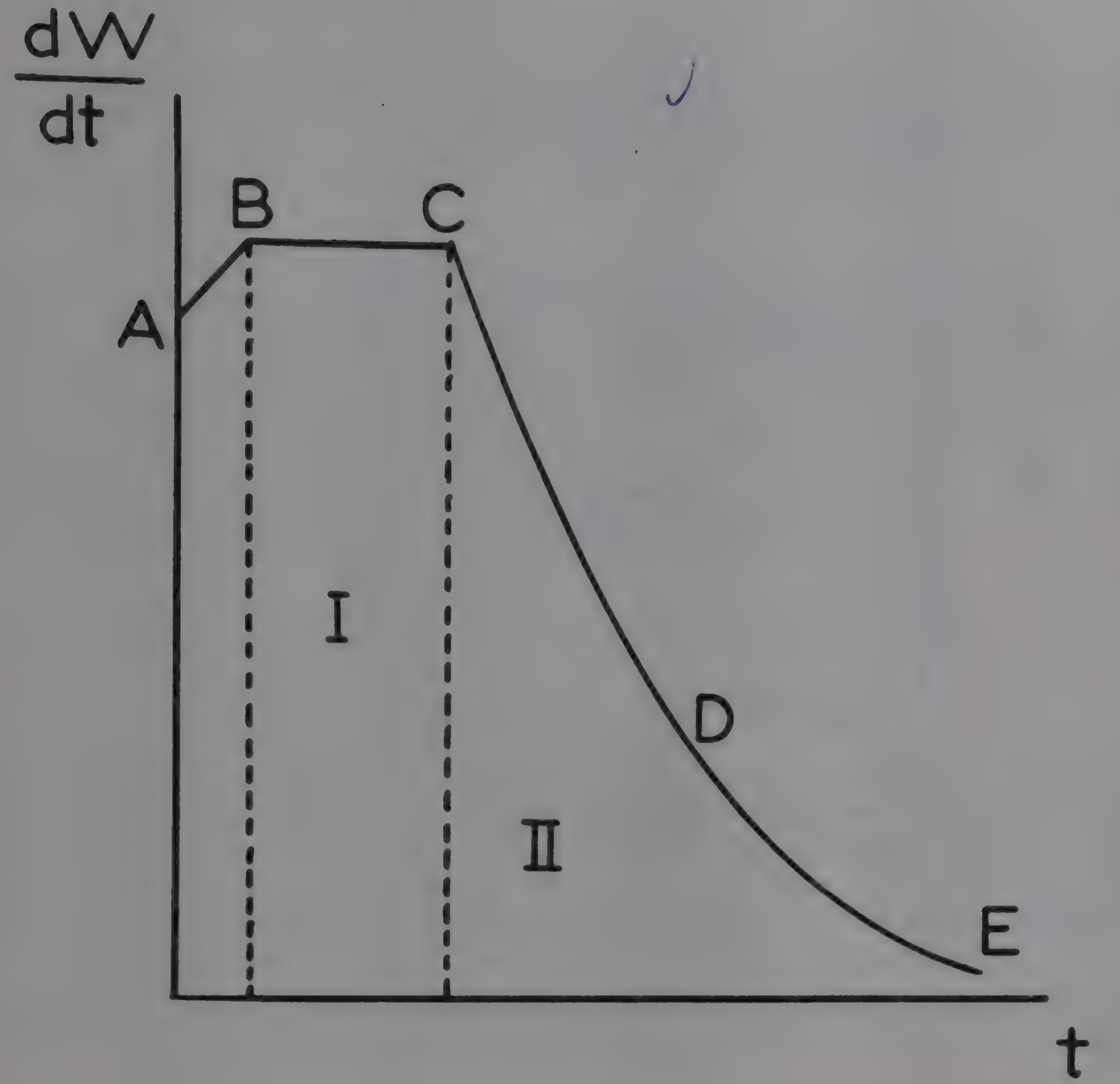
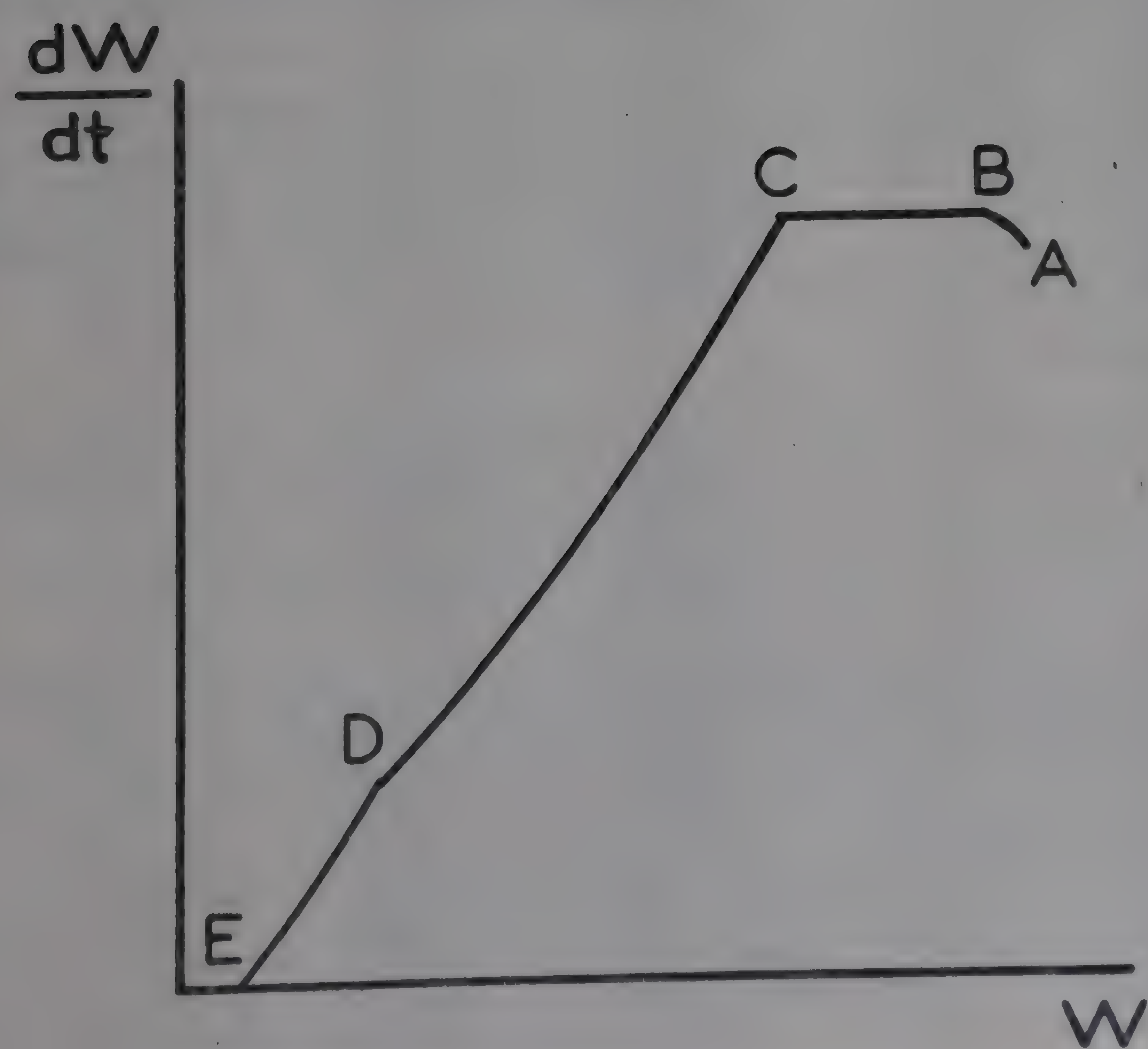


Figure 6.



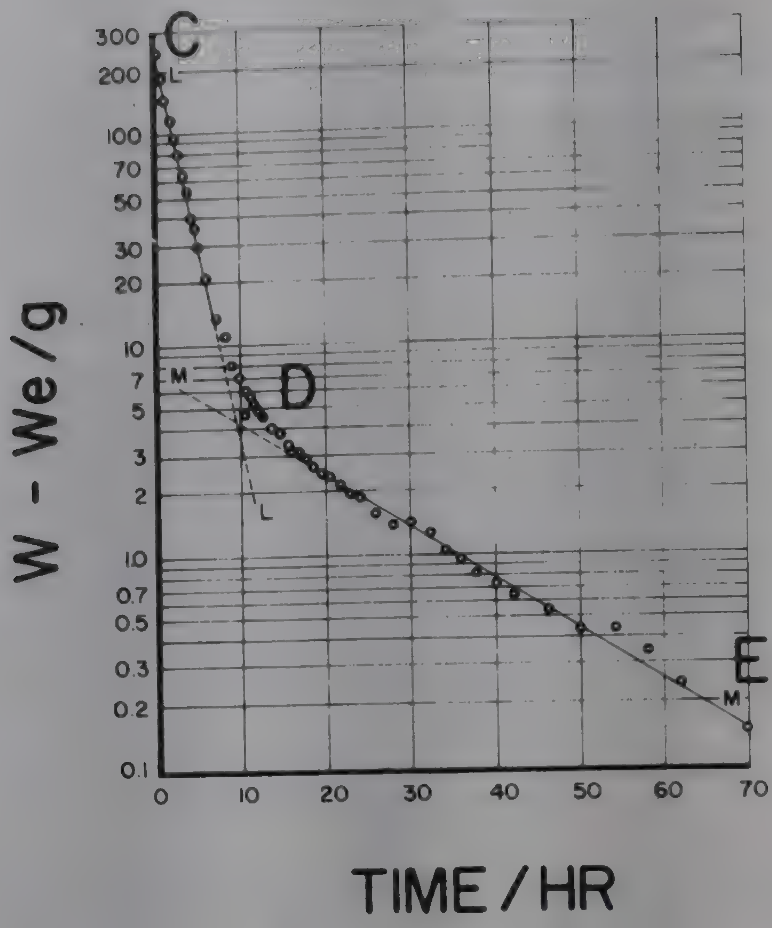


Fig. 7

When t is large, that is for long drying times, the above series solution is conveniently reduced to:

$$\frac{W - W_e}{W_c - W_e} = \frac{8}{\pi^2} \exp \left[\frac{D\,t\,\pi^2}{d^2} \right]$$

Thus, the drying time can be predicted for any value of moisture content. Also the plot of free moisture against drying time on a semi-logarithmic basis should give a linear graph with a slope equals to $\pi^2 D/d^2$, from which the diffusion coefficient can be evaluated.

In comparison to constant-rate period, the falling-rate period is determined by internal conditions, namely those that effect the moisture movement away from the solid in addition to the rate of internal moisture movement. It is for this reason that unlike the constant-rate period, where we have considerable control over the drying rate parameters such as air velocity and air temperature, there is relatively little control over the drying process in the falling-rate period.

APPLICATION OF MODELS TO DRYING OF FISH

In his extensive work on dehydration of cod muscle, Jason (1958) found that the drying of fish during the falling-rate period can be divided into two phases, each characterized by two different values of diffusion coefficient. The coefficient for the first phase was considerably greater than that of the second phase as evident in the slope of the semi-log plot of free moisture ($W - W_e$) against time of drying (t) (Figure 7).

It can be concluded that, with fish, the mechanism of liquid diffusion as the model of moisture movement through the solids has been successfully applied. Also it is possible to assume a two-stage diffusion process which possesses two constant values for the diffusion coefficient at different moisture content ranges. Actually, there is some discrepancy between predicted and experimental values which is indicative of the simplifying assumptions employed in the development of the models. To account for the diffusion coefficient which is dependent on moisture content and shrinkage, a more rigorous mathematical model is required. Such a model would be based on a system of differential equations derived by Luikov and Mikhailov (1965) representing simultaneous heat and mass transfer. Applying such a theoretical analysis to Jason's study, a closer correlation is observed between the predicted values and the observed values (Figure 8).

DEHYDRATATION BY SOLAR ENERGY

In food engineering definition, dehydration is the unit operation in which the removal of water is carried out with the application of heat under controlled conditions. By this definition, sun drying is not included under this category because of the lack of control over the drying conditions.

The application of solar energy, however, as a source of heat in dehydration processing of fish is certainly the principal method of preservation in tropical countries. The use of direct and indirect solar driers is becoming economically attractive especially in view of the global search for cheap alternative sources of energy. In such cases, the theoretical analysis of heat and mass transfer during solar drying has to take into account the fact that heating is now carried out under two major mechanisms of convection and radiation. The coupled effect will have to be accommodated in the conventional equation for heated air drying.

$$\frac{dw}{dt} = \frac{h\ A}{L} \quad (T_a - T_s) \quad + \frac{a\ \varepsilon\ A}{L} \quad \sigma \quad (T_r^4 \ - \ T_s^4)$$

CONCLUSION

Although drying is a very old processing operation, our knowledge is still very limited. This is because drying is an extremely complicated process. There has been a recent breakthrough, however, in the physical aspects of dehydration which is made possible only by the development and application of computing systems particularly in terms of prediction of drying times. But much remains to be done, further theories and calculation procedures need to be formulated to simulate complicated food materials being dried under more complex conditions.

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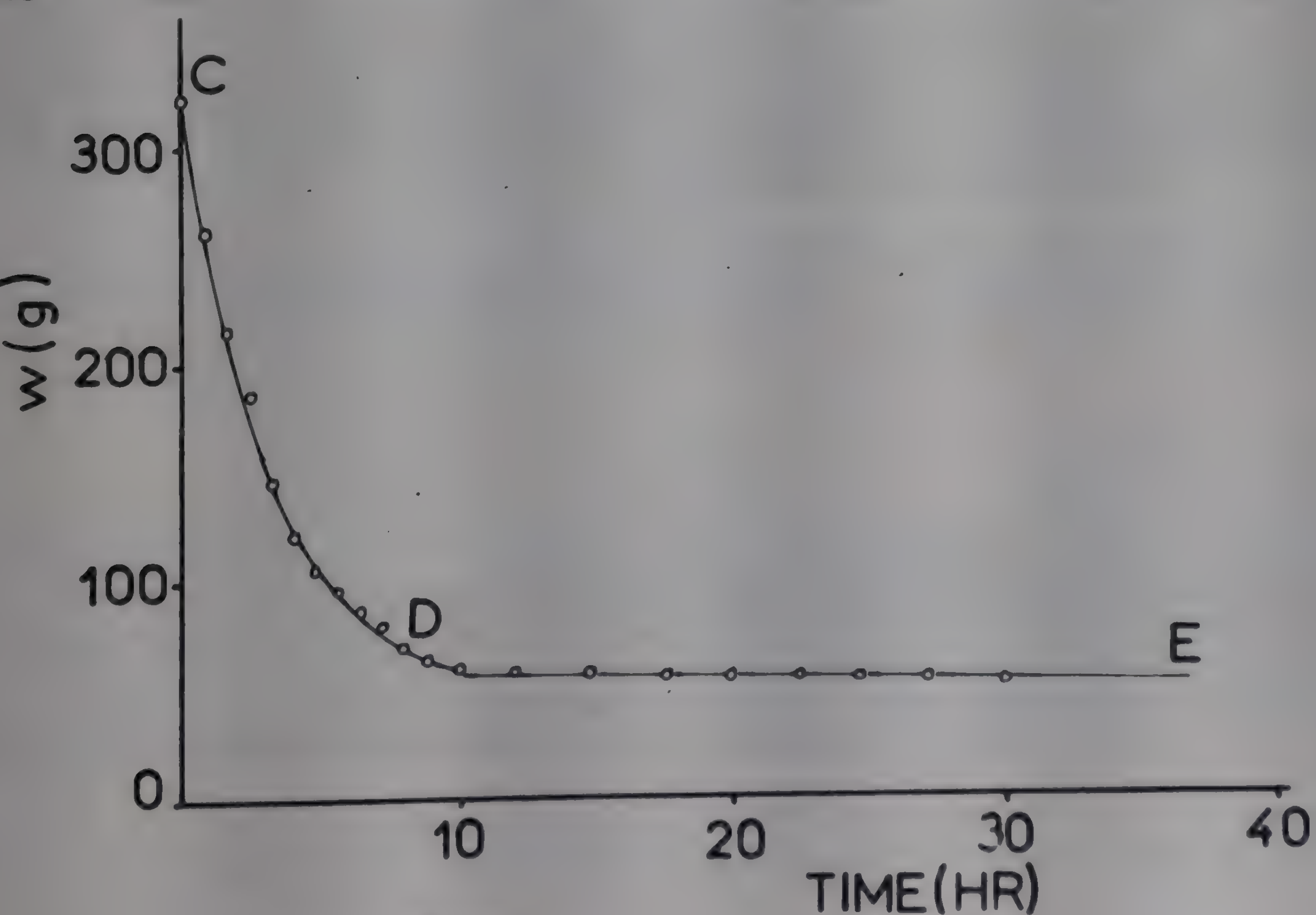

Figure 8

DETERMINATION OF THE WATER ACTIVITY AND SHELF LIFE OF DRIED FISH PRODUCTS

by

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ABSTRACT

The microbial stability of dried fish products is dependent upon their water activity. However, the methods available for measuring this property are often highly specialized, tedious and unreliable. This paper presents a simple method for calculating the water activity of dried fish from the water and salt contents. This can then be used in conjunction with growth data for moulds to estimate the storage life of these products under tropical conditions.

INTRODUCTION

Drying and salting are traditional methods which have been used for centuries for preserving fish (Cole and Greenwood-Barton, 1965; Waterman, 1976). The microbial stability of dried fish products during processing and storage is dependent upon their water activity, a_w (Scott, 1957; Waterman, 1976; Chirife and Iglesias, 1978; Troller and Christian, 1978). This is a measure of the free water in a food which is available to react chemically or to support the growth of microorganisms, such as bacteria and moulds, during spoilage (Waterman, 1976). The a_w of fresh fish is above 0.95 and can be reduced by processes such as drying and salting which will lead to a reduction in microbial growth as well as decreasing the range of microorganisms which can grow. Most spoilage bacteria will cease to grow at an a_w of below 0.90 and the growth of most moulds is inhibited below 0.80.

Water activity measurement is tedious, time-consuming and subject to error (Troller and Christian, 1978). It can also involve the use of expensive laboratory equipment. In comparison, the determination of water and salt contents is relatively simple and precise and can be completed within a few hours.

A method for calculating the a_w of dried products from their water and salt contents is presented as well as a means of estimating their storage life under tropical conditions.

METHODS

Water Activity Determinations

The experimental work was carried out on cod, *Gadus morrhua*, a cold water marine species (Doe *et al.*, 1982) and lisa, *Xenomugil thoburni*, a tropical marine species (Curran and Poulter, in press) at the Tropical Products Institute (TPI). In addition, data from Kuo and Pan (1979) on round herring (*Etrumeus micropus, Sardinops melanostica* Temminck and Schlegel) have been used. Details of processing methods, a_w determinations, and water and salt content measurements are given in the publications to which reference has been made.

Calculation of Water Activity from Water and Salt Contents

Ross (1975) proposed that the a_w of intermediate moisture foods could be found from the product of the a_w's of the individual component of the food, such as solutes, starches and proteins. Doe *et al.* (1982) applied this principles to dried salted fish. It was assumed that fish have only four components: water, salt, fat and fish muscle (protein). Since fat is strongly hydrophobic, it plays no part in the calculation provided that water and salt contents are expressed on a fat-free, dry matter basis (Leistner, 1976; Iglesias and Chirife, 1977). Therefore, the a_w of dried salted fish can be calculated from the expression:

$$a_w = a_{wn} \cdot a_{wo} \qquad (1)$$

where a_{wn} is the water activity of the salt-water component of the fish and a_{wo} is the water activity of the fish muscle. The a_w of the salt in the fish is taken to be equal to that of a pure sodium chloride solution at a molality, m, calculated from the measured water and salt contents using the expression:

$$m = 17.09\ (M_s/M_b) \cdot (M_b/M_w) \qquad (2)$$

where M_s is the mass of salt, M_w is the mass of water and M_b is the fat-free, salt-free dry mass. The relationship between m and a_w can be found from published vapour pressure data for sodium chloride (Robinson and Stokes, 1959). Values for a_{wo} at different water contents are found by applying Equation 1 to the sorption isotherm for unsalted cod (Doe *et al.*, 1982).

Recently work has been carried out at TPI in London to investigate the effect of species and drying temperature on a_w values. The initial results suggest that these may have little practical influence.

Assessment of Shelf Life

Dried salted fish processed in tropical countries are liable to spoil during storage as a result of mould attack, particularly by the dun mould, *Wallemia sebi* syn. *Sposendonema epizoum* (Troller and Christian, 1978).

One of the authors (R.G.P.) conducted storage trials on seven different tropical fish species at the Institute of Fish Technology in Sri Lanka from December 1979 to July 1980 (Poulter, Doe and Olley, 1982). The fish were salted and dried by the usual local commercial processes and were then stored under conditions similar to those found in commercial dry fish stores in Sri Lanka. No attempt was made to control temperature and humidity in the store rooms. During the storage trials, the fish were examined weekly to estimate the extent of mould growth, pinking, beetle attack, rancidity and putrefaction. Water and salt contents were also determined at regular intervals.

Kuo and Pan (1979) studied commercially dried round herring. Samples were stored for up to four months at 14.4°C ± 1.8 and 79% RH ± 5. During storage, measurements were made of a_w, water and salt contents, aerobic plate counts, colour, trimethylamine-nitrogen and ammonia-nitrogen.

RESULTS

Water Activity Measurements

Table 1 gives the a_w values corresponding to different water (M_w/M_b) and salt (M_s/M_b) contents calculated using Equation 1. The results of measured a_w (a_w meas.) and water, salt and fat (M_f/M_b) contents for cod, lisa and round herring are given in Table 2. In addition, the a_w values calculated (a_w calc.) using Table 1 and corresponding to the measured water and salt contents are also given in Table 2.

Figure 1 is a plot of the measured a_w against the calculated a_w for the data in Table 2. A least squares linear regression fit of these data gives the relationship:

$$a_w(\text{calc.}) = 0.977\ a_w(\text{meas.}) + 0.021 \qquad (3)$$

with a correlation coefficient, $r = 0.99$ ($p < 0.001$).

Storage Trials

The curve shown in Figure 2 represents the times for germination and growth of visible colonies of *W. sebi* at different a_w values (Pitt and Hocking, 1979; Shewan, 1953). Plotted on this Figure are the a_w values calculated from the water and salt contents measured during the storage trials. Most of the samples with an a_w above the curve had colonies of mould present; only those samples which had been smoked or which were heavily infested by beetles did no exhibit mould growth. In all cases, the fish with an a_w below the curve showed no mould growth.

DISCUSSION

The results of Figure 1 show that there is good agreement between the measured a_w values and those calculated from the water and salt contents of the dried fish products. In addition, the storage trials demonstrated that the growth curve for *W. sebi* can be used to predict the mould-free shelf life of dried fish. The results of Kuo and Pan (1979) do not differ significantly from those of Poulter, Doe and Olley (1982), except that *Penicillium* spp. moulds were found on the Taiwan fish rather than dun mould.

Therefore, using the method described in this paper for calculating the a_w of fish samples and the growth curve in Figure 2, it is possible to make a rapid assessment of the length of time which fish can be stored before mould growth will occur provided that the a_w remains constant during storage. If the fish become rehydrated under conditions of high relative humidity, through exposure to rain or dew, or when condensation occurs within the packaging due to a rapid fall in temperature, the a_w will rise and the storage life will be reduced. Obviously, it is desirable to control the temperature and humidity in storehouses to combat these problems.

CONCLUSIONS

There is a good correlation between the measured a_w values of dried fish and those calculated from their water and salt contents. In addition, the results of dried storage trials on several tropical species are in agreement with shelf life predictions derived from growth data for dun mould. It is, therefore, possible to calculate the a_w and predict the mould-free shelf life of dried-salted fish products simply and rapidly, and with a reasonable degree of accuracy.

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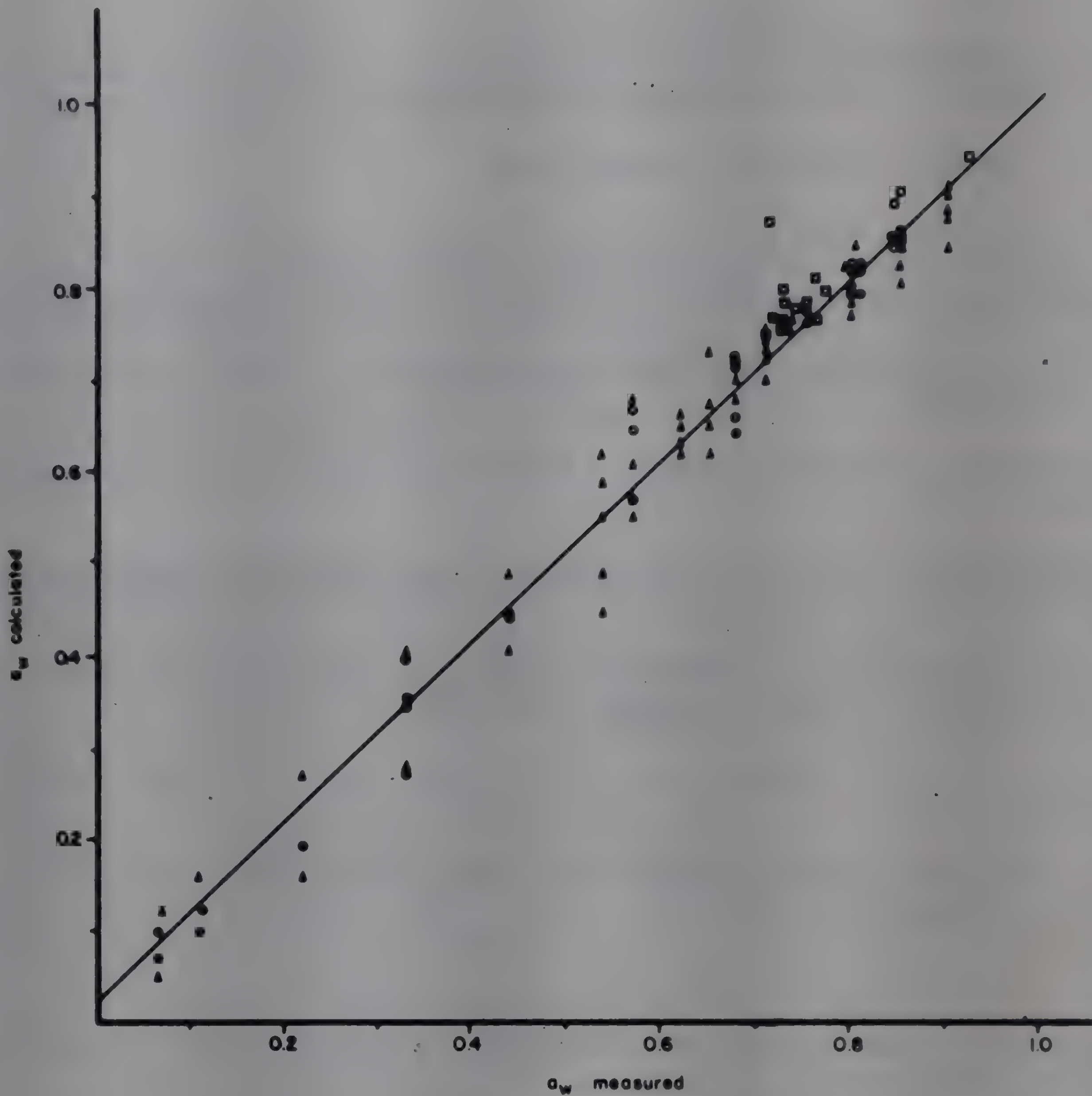

Fig. 1 Relationship between measured and calculated water activities: o cod, ▲ lisa, □ round herring

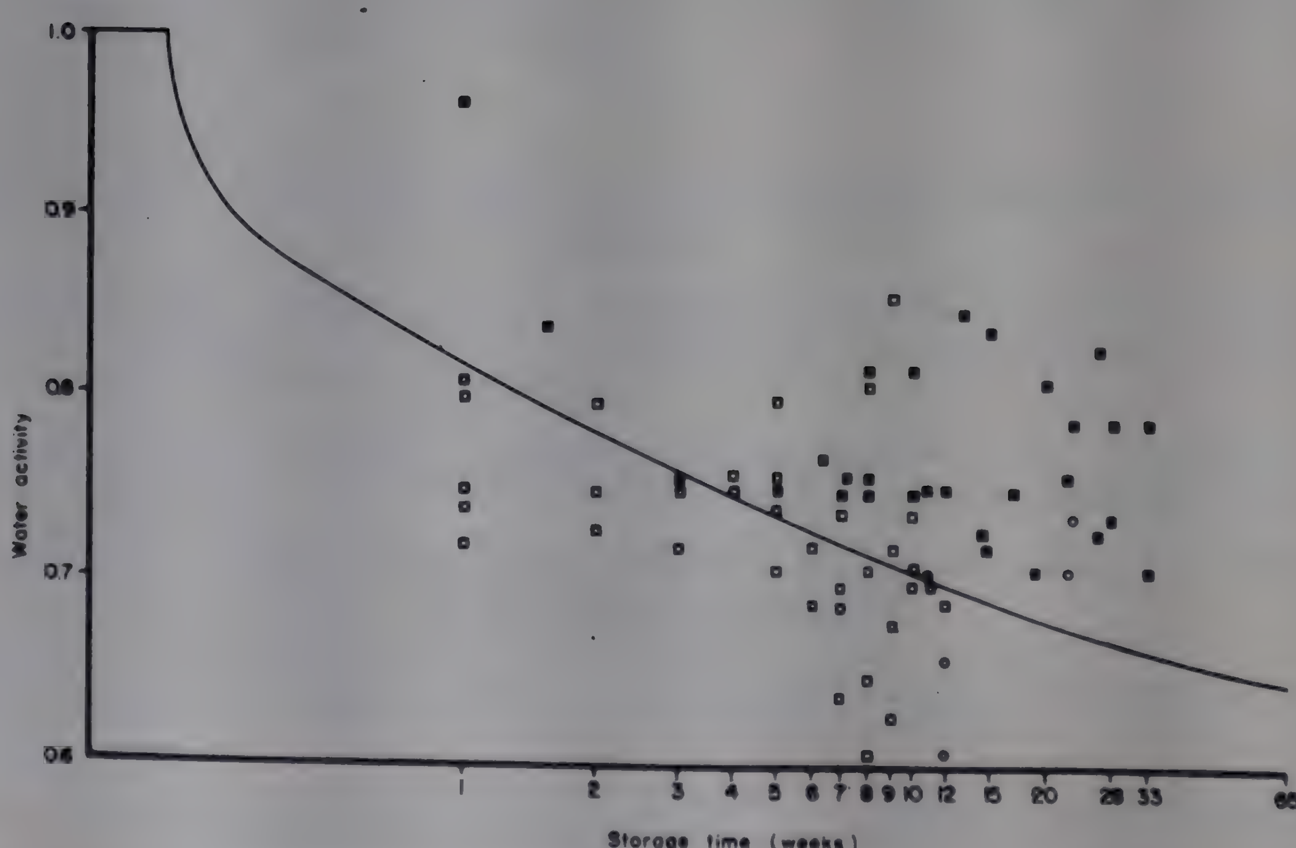

Fig. 2 Growth curve for appearance of visible colonies of dun mould, W. sebi, with water activities of stored fish. Results of storage trials: □ no mould or beetles; ■ mould; o beetles; ■ mould and beetles

Table 1

Water activities from water and salt contents

Salt content (M_s/M_b)

Water content (M_w/M_b)	0	.02	.04	.06	.08	.10	.12	.14	.16	.18	.20	.22	.24	.26	.26	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95	1.0
.02	.04	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.04	.09	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
.06	.17	.13	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12
.08	.26	.21	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19
.10	.47	.41	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35
.12	.59	.53	.46	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44
.14	.69	.63	.56	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51
.16	.75	.69	.63	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56
.18	.80	.74	.68	.61	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60
.20	.83	.79	.73	.67	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62
.22	.86	.82	.77	.71	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65
.24	.89	.85	.80	.75	.69	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67
.26	.91	.87	.82	.78	.72	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68
.28	.93	.89	.85	.80	.75	.70	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69
.32	.95	.92	.88	.84	.80	.75	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71
.36	.96	.93	.90	.87	.83	.79	.74	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72
.40	.97	.95	.92	.89	.85	.82	.78	.74	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73
.44	.98	.96	.93	.90	.87	.84	.81	.77	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74
.48	.99	.96	.94	.91	.89	.86	.83	.80	.76	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74
.52	.99	.97	.95	.93	.90	.87	.85	.82	.79	.75	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74
.56	1.0	.98	.96	.93	.91	.89	.86	.84	.81	.78	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.60	1.0	.98	.96	.94	.92	.90	.87	.85	.82	.80	.77	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.64	1.0	.98	.96	.94	.93	.90	.88	.86	.84	.81	.79	.76	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.68	1.0	.98	.97	.95	.93	.91	.89	.87	.85	.83	.80	.78	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.72	1.0	.98	.97	.95	.93	.92	.90	.88	.86	.84	.82	.78	.77	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.76	1.0	.99	.97	.96	.94	.92	.90	.89	.87	.85	.83	.81	.79	.76	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.80	1.0	.99	.97	.96	.94	.93	.91	.89	.88	.86	.84	.82	.80	.78	.76	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.84	1.0	.99	.97	.96	.95	.93	.92	.90	.88	.87	.85	.83	.81	.79	.77	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.88	1.0	.99	.98	.96	.95	.93	.92	.90	.89	.87	.86	.84	.82	.80	.79	.76	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.92	1.0	.99	.98	.96	.95	.94	.92	.91	.89	.88	.86	.85	.83	.81	.80	.78	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.96	1.0	.99	.98	.97	.95	.94	.93	.91	.90	.88	.87	.85	.84	.82	.81	.79	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
1.0	1.0	.99	.98	.97	.96	.94	.93	.92	.90	.89	.88	.86	.85	.83	.82	.80	.76	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
1.5	1.0	.99	.98	.98	.97	.96	.95	.95	.94	.93	.92	.91	.90	.89	.89	.88	.85	.83	.80	.77	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
2.0	1.0	1.0	.99	.98	.98	.97	.97	.96	.96	.95	.94	.94	.93	.92	.92	.91	.89	.88	.86	.84	.82	.80	.78	.76	.75	.75	.75	.75	.75	.75
2.5	1.0	1.0	.99	.99	.98	.98	.97	.97	.96	.96	.96	.95	.95	.94	.94	.93	.92	.90	.89	.88	.87	.85	.83	.82	.80	.78	.77	.75	.75	.75
3.0	1.0	1.0	.99	.99	.99	.98	.98	.97	.97	.97	.96	.96	.96	.95	.95	.94	.93	.92	.91	.90	.89	.88	.86	.85	.84	.83	.81	.80	.79	.77
3.5	1.0	1.0	.99	.99	.99	.98	.98	.98	.98	.97	.97	.96	.96	.96	.96	.95	.94	.93	.92	.92	.91	.90	.89	.88	.87	.86	.84	.83	.82	.81
4.0	1.0	1.0	1.0	.99	.99	.99	.98	.98	.98	.98	.97	.97	.97	.96	.96	.96	.95	.94	.93	.93	.92	.91	.90	.89	.88	.88	.87	.86	.85	.84

Table 2

Water, salt and fat contents with measured and calculated water activities of cod[a], lisa[b], and round herring[c]

Species	M_w/M_b	M_s/M_b	M_f/M_b	a_w meas.	a_w calc.
Cod	2.63	0.91	0.05	0.75	0.762
	2.55	0.88	0.05	0.75	0.762
	1.55	0.45	0.05	0.80	0.808
	2.86	0.87	0.05	0.80	0.797
	2.99	0.86	0.05	0.80	0.810
	3.30	0.93	0.05	0.81	0.815
	3.49	0.86	0.05	0.84	0.841
	3.38	0.80	0.05	0.85	0.849
	1.91	0.67	0.05	0.75	0.757
	2.69	0.99	0.05	0.75	0.750
	2.90	1.03	0.05	0.75	0.753
	1.75	0.57	0.05	0.80	0.779
	3.04	0.91	0.05	0.80	0.801
	2.83	0.87	0.05	0.80	0.794
	3.14	0.99	0.05	0.81	0.787
	3.17	0.84	0.05	0.84	0.828
	3.33	0.82	0.05	0.85	0.842
	1.49	0.60	0.05	0.75	0.750
	2.76	1.00	0.05	0.75	0.750
	2.16	0.69	0.05	0.80	0.784
	3.15	0.93	0.05	0.80	0.804
	3.25	0.96	0.05	0.81	0.804
	3.31	0.84	0.05	0.85	0.836
	0.05	1.00	0.05	0.07	0.096
	0.11	1.10	0.05	0.33	0.398
	0.10	1.60	0.05	0.33	0.352
	0.12	1.30	0.05	0.44	0.443
	0.21	1.20	0.05	0.57	0.635
	0.23	1.20	0.05	0.57	0.656
	0.33	1.10	0.05	0.68	0.715
	0.30	1.10	0.05	0.68	0.703
	0.31	1.10	0.05	0.68	0.706
	0.03	1.20	0.05	0.07	0.05
	0.04	1.20	0.05	0.07	0.07
	0.04	1.20	0.05	0.07	0.07
	0.06	1.30	0.05	0.11	0.12
	0.05	1.30	0.05	0.11	0.10

Species	M_w/M_b	M_s/M_b	M_f/M_b	a_w meas.	a_w calc.
Cod	0.08	1.40	0.05	0.22	0.19
	0.09	1.40	0.05	0.33	0.27
	0.10	1.40	0.05	0.33	0.35
	0.12	1.40	0.05	0.44	0.44
	0.12	1.40	0.05	0.44	0.44
	0.16	1.40	0.05	0.57	0.56
	0.16	1.40	0.05	0.57	0.56
	0.22	1.30	0.05	0.68	0.65
	0.21	1.30	0.05	0.68	0.63
	0.36	1.30	0.05	0.71	0.72
	0.37	1.30	0.05	0.71	0.72
Lisa	0.06	0.54	0.019	0.07	0.12
	0.07	0.74	0.021	0.11	0.16
	0.08	0.45	0.018	0.22	0.19
	0.10	0.52	0.018	0.33	0.35
	0.11	0.47	0.018	0.44	0.40
	0.19	0.73	0.021	0.54	0.61
	0.15	0.50	0.018	0.57	0.54
	0.21	0.76	0.021	0.62	0.64
	0.35	0.88	0.023	0.65	0.72
	0.25	0.69	0.021	0.68	0.67
	0.33	0.47	0.018	0.71	0.71
	0.92	1.00	0.025	0.735	0.75
	0.82	0.82	0.022	0.75	0.75
	1.87	0.55	0.019	0.85	0.81
	2.38	0.63	0.020	0.90	0.83
	0.03	0.72	0.021	0.07	0.05
	0.05	0.73	0.021	0.11	0.10
	0.09	0.69	0.020	0.22	0.27
	0.10	0.54	0.019	0.33	0.35
	0.12	0.59	0.019	0.44	0.44
	0.13	0.81	0.022	0.54	0.48
	0.24	0.74	0.021	0.57	0.67
	0.19	0.85	0.022	0.62	0.61
	0.21	0.83	0.022	0.65	0.64

Species	M_w/M_b	M_s/M_b	M_f/M_b	a_w meas.	a_w calc.
Lisa	0.27	0.78	0.022	0.68	0.69
	0.34	0.63	0.020	0.71	0.72
	0.51	0.76	0.021	0.735	0.74
	0.92	0.55	0.019	0.75	0.75
	1.62	0.57	0.019	0.80	0.76
	2.37	0.75	0.021	0.85	0.79
	2.48	0.55	0.019	0.90	0.86
	0.05	0.69	0.030	0.07	0.10
	0.05	0.51	0.028	0.11	0.10
	0.07	0.49	0.027	0.22	0.16
	0.09	0.63	0.030	0.33	0.27
	0.11	0.54	0.028	0.44	0.40
	0.12	0.47	0.027	0.54	0.44
	0.16	0.62	0.030	0.57	0.56
	0.22	0.54	0.028	0.62	0.55
	0.19	0.52	0.029	0.65	0.61
	0.28	0.59	0.029	0.68	0.69
	0.27	0.52	0.028	0.71	0.69
	0.59	0.64	0.030	0.735	0.75
	1.31	0.98	0.036	0.75	0.75
	1.64	0.53	0.030	0.80	0.78
	1.84	0.52	0.028	0.85	0.81
	2.13	0.45	0.027	0.90	0.87
	0.06	0.22	0.038	0.07	0.12
	0.07	0.20	0.037	0.11	0.16
	0.09	0.20	0.037	0.22	0.27
	0.11	0.21	0.038	0.33	0.40
	0.13	0.19	0.037	0.44	0.48
	0.17	0.24	0.039	0.54	0.58
	0.18	0.21	0.038	0.57	0.60
	0.21	0.21	0.038	0.62	0.64
	0.23	0.22	0.038	0.65	0.66
	0.29	0.24	0.039	0.68	0.69
	0.42	0.23	0.038	0.71	0.74
	0.55	0.22	0.038	0.735	0.75
	0.59	0.21	0.038	0.75	0.76
	0.80	0.23	0.038	0.80	0.83

Species	M_w/M_b	M_s/M_b	M_f/M_b	a_w meas.	a_w calc.
Lisa	0.89	0.22	0.038	0.85	0.84
	1.12	0.21	0.038	0.90	0.89
	0.06	0.22	0.056	0.07	0.12
	0.07	0.23	0.057	0.11	0.16
	0.09	0.26	0.056	0.22	0.27
	0.10	0.25	0.058	0.33	0.35
	0.13	0.26	0.058	0.44	0.48
	0.15	0.22	0.056	0.54	0.54
	0.18	0.28	0.059	0.57	0.60
	0.20	0.24	0.057	0.62	0.62
	0.19	0.16	0.054	0.65	0.61
	0.24	0.21	0.056	0.68	0.67
	0.41	0.25	0.058	0.71	0.73
	0.54	0.21	0.060	0.735	0.75
	0.62	0.25	0.058	0.75	0.75
	0.89	0.25	0.058	0.80	0.81
	0.93	0.24	0.057	0.85	0.83
	1.72	0.31	0.061	0.90	0.90
Round herring	0.97	0.12		0.92	0.928
	0.81	0.14		0.85	0.894
	0.72	0.14		0.84	0.878
	0.84	0.24	0.14	0.80	0.811
	0.49	0.15		0.77	0.785
	0.63	0.22		0.76	0.755
	0.54	0.16	0.16	0.76	0.798
	0.51	0.17		0.75	0.765
	0.59	0.20		0.74	0.765
	0.51	0.19		0.73	0.745
	0.43	0.18	0.07	0.73	0.735
	0.49	0.15	0.13	0.73	0.785
	0.39	0.12	0.13	0.73	0.770
	0.44	0.15	0.15	0.72	0.753
	0.42	0.14	0.09	0.72	0.755
	0.42	0.16	0.06	0.71	0.734
	0.35	0.06	0.08	0.71	0.860

Source: a/ Poulter, Doe and Olley, 1982

b/ Curran and Poulter, 1982

c/ Kuo and Pan, 1979

SPOILAGE OF DRIED FISH
THE NEED FOR MORE DATA ON WATER ACTIVITY AND TEMPERATURE EFFECTS ON SPOILAGE ORGANISMS

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ABSTRACT

Spoilage of dried fish may be due to bacterial, fungal or yeast action, rancidity, autolysis, browning and other reactions, all of which are temperature and water activity dependent. To avoid spoilage, drying needs to be sufficiently rapid and, in subsequent storage water activity, to be sufficiently low to limit the growth of the various micro-organisms and the rate of the other spoilage reactions. There is a paucity of data in the literature on the growth rates of likely spoilage organisms at the temperatures and water activities likely to be encountered when drying fish. Detailed microbiological studies and controlled drying measurements need to be carried out before improved drying techniques can be recommended.

INTRODUCTION

The dependence of microbial growth on temperature and water activity is well established (Troller and Christian, 1978). Recent work has shown that water activity is salted dried fish can be estimated by the relatively simple process of measuring the moisture. salt and fat contents of the fish (Doe, Poulter and Curran, 1982). Also, it has been demonstrated that the known growth times, to a particular colony size, of the mould *Wallemia sebi*, suitably adjusted to allow for the effect of a continuous change in water activity, provide a guide to the storage life of several fish species (Poulter, Doe and Olley, 1982).

In the course of extending this work to the spoilage of fish by bacterial and other causes it was found that there is little data in the literature on water activity as distinct from temperature effects.

This paper looks at the time, temperature and water activity tolerances of certain fungi and makes a plea for similar measurements to be made on the common spoilage bacteria, moulds and yeasts associated with dried fish in tropical countries.

CAUSES OF SPOILAGE IN DRIED FISH

Descriptions of the types of spoilage of dried fish can be found in papers by Waterman (1976), Shamsuddoha (1964), Cole and Greenwood-Barton (1965) and others. Spoilage can occur at all stages of processing from the time of capture through the brining and drying process and in storage. Whether or not spoilage will occur depends on the temperature and water activity of the fish and the presence or absence of the various spoilage micro-organisms and insects.

BACTERIAL SPOILAGE

W.J. Scott is credited with establishing that the growth of micro-organisms is as much dependant on water activity as temperature. Scott (1936, 1936a) measured the growth of *Achromobacter* and *Pseudomonas* spp., also three species of asporogeneous yeasts on ox muscle at -1^{o}C, 2^{o}C and 4^{o}C in the range of a_w from 0.993 to 0.90.

Troller and Christian (1978) refer to the effects on microbial growth of other environmental factors (ph, O_2 and CO_2 concentrations) besides temperature and water activity. Some data are given, for example the growth curves for *S. aureus* in the range of a_w 0.9 to 0.99 and the effects of temperature, ph and a_w on the growth of *C. botulinum*.

Wodzinski and Frazier (1960, 1961, 1961a, 1961b, 1961c) measured the effects of ph, O_2, CO_2 concentrations, temperature and water activity on the lag and germination times of *Pseudomonas fluorescens*, *Aerobacter aerogenes*, *Lactobacillus viridescens* and *Achromobacter*.

Ratkowsky *et al.* (1982) showed that, at water activities close to unity, a linear relationship exists between the square root of the growth rate of bacteria and temperature. Moreover, the lines thus formed intersect the zero growth rate axis at a particular temperature, T_o, which is a characteristic of the organism involved rather than the substrate or culture medium.

Spoilage during the drying of fish is attributed to micrococci and Gram-positive rods (Liston, 1980). Sachithananthan (1976) reports the presence of *E. coli* on locally dried fish in Sri Lanka. Spoilage may also occur in brining through pinking caused by the red obligate halophiles (Troller and Christian, 1978; Disney, Cole and Jones, 1974).

The bulk data on the growth rates of fish spoilage bacteria relates to pathogenic spoilage of fresh, canned, chilled and frozen fish at water activities near unity. There appears to be little, if any, published data on the time-temperature-water activity relationships for the spoilage bacteria of salted dried fish.

Moulds and Yeasts

Much more information is available on the spoilage moulds associated with dried fish than on bacteria. Dun mould, *Wallemia sebi* (syn. *Sporendonema epizoum*), is commonly found on dried fish in tropical countries (Waterman, 1976; Troller and Christian, 1978; Frank and Hess, 1941). Other moulds (*Aspergilus* spp., and *Penicillium* spp.) are also reported to occur on dried fish (Liston, 1980; Kuo and Pan, 1979). The human pathogenic fungus, *Exophiala werneckii*, has been recovered from salted dried fish in South America (Mok, Castello and Baretto da Silva, 1981).

Pitt and Hocking (1977) presented data on the germination times at 25°C for *W. Sebi* at different a_w's and ph; this data together with growth rates at the same temperature was used by Poulter, Doe and Olley (1982) to predict the storage life of dried salted fish. Casolari, Spotti and Castelverti (1979) studied the growth of six osmophilic yeasts and found that an exponential relationship between growth time and water activity fitted the measurements fairly well; however, the study was at one temperature only (25°C).

The most complete time-temperature-a_w data is that of Ayerst (1969). Ayerst presents charts for a number of fungi (*W. sebi* not included) as contours of growth rates plotted on a_w - temperature axes with germination times also shown.

Little is known about the occurrence of toxigenic moulds on drying and dried fish, or whether the production of toxins could be a significant hazard. The reported presence of human pathogens, such as *Exophiala*, must also be of concern.

Other Spoilage Causes

Enzymic breakdown, also known as autolysis, occurs in the drying of some fish (Young, *et al.*, 1973). This can be intentional as in the case of fermented products (Cole and Greenwood-Barton, 1965), but is usually undesirable. Troller and Christian (1978) list temperature and water activity as two of the factors affecting the stability of enzymes in foods; however, they do not refer specifically to enzyme activity in fish.

More is known of the non-enzymic browning reactions in fish. Troller and Christian (1978) report work on Maillard type reactions in cod and anchovies which peak at relatively low a_w levels with significant resistance to browning at a_w >75%. Extremely low moisture contents are needed (5-10%) to stabilize the colour of cod muscle, rather lower than normally attained in dry fish. Warmbier, Schnickels and Labuza (1976) caution that non-enzymic browning can cause significant nutritional losses.

Insect infestation, although a major problem with dried fish in tropical countries (Blatchford, 1962) can occur over a wide range of water activities (FAO, 1981), depending on the access of the various insects species to the fish. Insect infestation can cause local increases in moisture content which lead to microbial breakdown. Temperature control using a solar tent drier was found by Doe (1977) to be an effective method of preventing losses due to fly larvae. Adequate design of store houses and careful use of pesticides, particularly pyrethrins, has proven effective in controlling beetle infestation (Waterman, 1976). Insect infestation is not normally a problem with heavily salted fish.

SAFE DRYING RATES

The method of determining the storage life of dried salted fish developed by Doe *et al.* (1982), is based on the known growth rates of the spoilage mould *W. sebi* and is applicable to fish stored under essentially constant conditions of a_w. Where a_w is changing rapidly with time, as occurs when the fish are dried, it is necessary to allow for the variation of the growth rates of the spoilage organisms with a_w and temperature. Yu, Siaw and Indrus (1982) found that fish spoiled through microbial action during drying, if the drying was too slow, but did not distinguish between spoilage which occurred during drying and that which may have occurred in the subsequent storage before organoleptic evaluation. What follows is a method of assessing whether or not a particular drying rate of schedule will avoid microbial spoilage during the process of drying as distinct from storage.

Time-Temperature Tolerance

Ratkowsky *et al.* (1983), have extended the original straight line model relating the square root of growth rate and temperature to cover the full temperature range for observable growth. The new relationship has temperature T_{min} (T_o in the original formula) and T_{max} which predict the minimum and maximum bands for growth.

Figures 1a and 1b show the fit obtained for this model for the growth of two fungi - *Aspergillus chevalieri* and *Aspergillus amstelodami* - which both occur on dried and salted fish (Phillips and Wallbridge, 1977). Growth rates are calculated as the reciprocal of the time taken for the mould to grow to a particular size (1 mm diam.), using the data of Ayerst (1969). Time t, in days to a 1 mm diam. mould diameter is calculated from the expression:

$$t = t_G + 1/2\ r$$

where t_G is the minimum germination time in days and r is the growth rate in mm/day.

The 1/2 r factor relates to the time taken for a mould to grow to a 1-mm diam. colony at a rate of 1 mm/day.

It should be pointed out that the germination times given by Ayerst (1969) are grouped into ranges from 0 to 1 day, 1 to 2 days, 2 to 4 days, etc. Thus, the values of time to a particular mould size are only approximate. A factor not considered by Ayerst is the effect of the size of the innoculum. If innocula were much smaller than those used for experimental purposes, as one would expect in practical situations, the time interval for germination may be much longer (Pitt, pers. comm., 1982). Ayerst used malt extract media; ph was not specified. Pitt and Hocking (1977) showed that the type of solute used for a_w control together with ph influenced germination times and growth rates of xerophilic fungi.

THE TIME-TEMPERATURE-WATER ACTIVITY ENVELOPE

Although other factors such as ph, O_2, and CO_2 concentrations and nutrient levels are known to affect the growth of micro-organisms, the principle factors in fish drying and storage are temperature and water activity (FAO, 1981). The relationship between the time taken for bacteria to reach a given concentration, or for moulds of a certain size to develop can be plotted as a three dimensional surface for a particular organism. Figure 2 shows the surface for germination and growth to a 1 mm diam. colony of *A. chevalieri* plotted from Ayerst's data. Note that the time-temperature tolerance curves

of Figures 1a and 1b appear in Figure 2 as curves in vertical planes parallel to the time and temperature axes. It is suspected that the fin-like protuberance in the surface is an artifact arising from the grouping of germination times in Ayerst's data referred to above When more precise data are obtained for the various spoilage organisms involved, the Ratkowsky 1982 formula can be extended to describe the three-dimensional time-temperature-water activity surface.

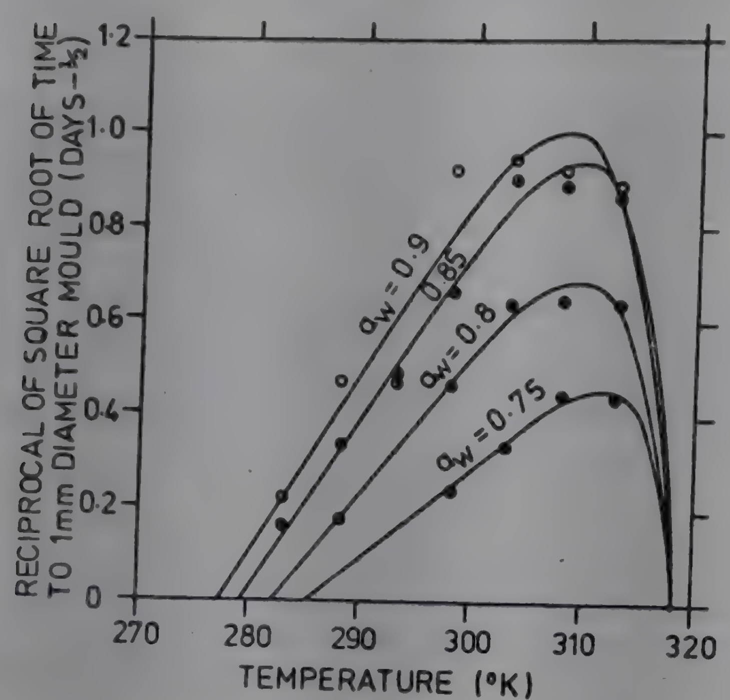

Figure 1a *A. chevalieri var intermedius*

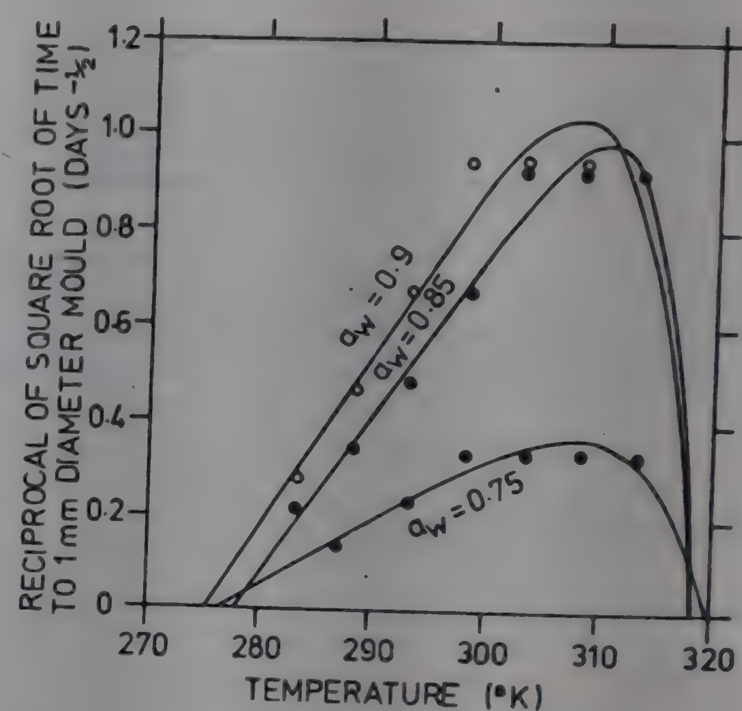

Figure 1b *A. amstelodami*

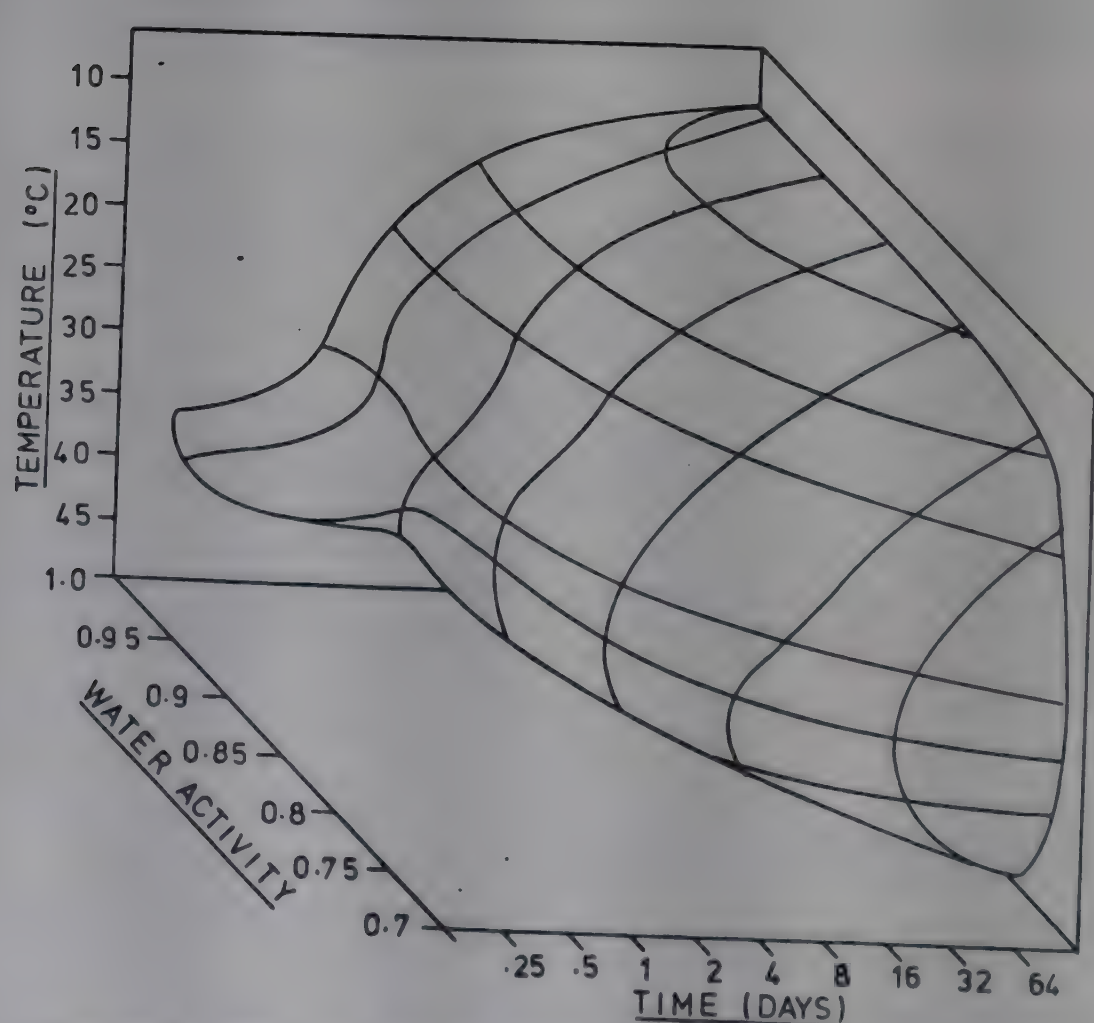

Figure 2 T-T-a_w surface for *A. chevalieri var intermedius*

If more than one spoilage organism is present there will be a group of mutually overlapping and intersecting surfaces, known to mathematicians as an "envelope" of surfaces which in effect predict when spoilage will occur if the fish, when being dried or stored, is held at a constant value of temperature and water activity.

The fact that fish are not usually dried under conditions of constant temperature and never at constant water activity gives rise to a problem in using the time-temperature-water activity (T-T-a_w) envelope for predicting safe drying and storage times. Fish dried to a particular value of temperature and a_w will have previously experienced higher levels of a_w and thus will have spoiled prior to the time indicated by the T-T-a_w envelope. This problem has been studied by Thijssen (1979) in relation to spray drying and by Poulter, Doe and Olley (1982) for fish. The Poulter, Doe and Olley technique is to evaluate an a_w exposure index by integrating the actual a_w-time curve during drying; this technique is applied by the inverse process of differentiating the a_w-time curve (for *W. sebi* at 25°C) and ensuring that the actual a_w-time drying curve for the fish does not intersect this differentiated curve. This technique can be extended to the three dimensional T-T-a_w envelope.

DISCUSSION

The technique developed by Poulter, Doe and Olley (1982), for estimating safe drying rates and storage times of salted and dried fish, although effective as regards storage life (Doe, *et al.*, 1982), needs to be extended to the three-dimensional T-T-a_w envelope to allow for temperature variation during drying, as well as spoilage, due to causes other than mould.

The construction of the T-T-a_w envelope requires more detail on the growth rates of the likely spoilage organisms than is presently available. The author is not aware of published data on germination times and growth rates of the principle spoilage mould *W. sebi* at temperatures other than 25°C (Pitt and Hocking, personal communication, 1982). Bacterial and enzymic spoilage is known to occur during the drying of fish in tropical countries, but very little is known of the growth rates or, indeed, the types of spoilage organisms involved.

CONCLUSION

With the recent developments in microbiological measurement techniques such as the Malthus device (Richards, 1978) and tools, such as temperature gradient incubators, together with the advances made in fitting growth curves to data obtained at a limited number of temperatures, it would not be too difficult or expensive a task to obtain the data required for the establishment of a time-temperature-water activity envelope for fish spoilage organisms. Accordingly, the author recommends that there be initiated a programme of identification and isolation of spoilage organisms together with a programme of measurement of the time-temperature-water activity growth relationships for these organisms. There is a need also for a series of measurements of water activity and temperature to be obtained from fish dried under controlled conditions so that the predictions of safe drying times obtained from the T-T-a_w envelope can be evaluated.

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SALT AND MOISTURE CONTENTS OF MALAYSIAN DRIED FISH

by

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ABSTRACT

Sun drying and salting are the most important fish preservation methods in Malaysia. Being the cheapest and simplest means of producing dried and salted fish, these methods which have been used for a long time, are likely to stay; especially with the current energy crisis and economic depression.

This paper presents the results of a study conducted to determine the salt and moisture contents of retail sun-dried fish and fishery products. The results are subsequently expressed in terms of their water activity, a_w. It was found that the salt content for large fish (600 g in weight) ranged from 20%-24% while the moisture content ranged from 33%-40%. Salt and moisture values for medium fish (50-600 g in weight) were in the range of 14%-23% and 24%-42% respectively. Small fish (50 g in weight) had salt values from 9%-25% and moisture 13%-35%. Dried fishery products, e.g., squid, dried shrimp and oyster had salt values in the range of 3%-8% and moisture 11%-24%. The a_w of these dried fish and fishery products ranges from 0.56% to 0.80%.

The importance of salt, moisture contents and a_w in fish preservation are also discussed in relation to stability and quality.

INTRODUCTION

Sun drying is perhaps the oldest technology known to man. It is a simple process which does not require any specialized equipment. In Malaysia traditional method of sun drying of fish with or without salting is still carried out and is the most important fish preservation method available.

Methods of improving traditional fish drying have been studied by various workers. Although these technical improvements result in better quality products than those of sun-dried products, the methods are too expensive and sophisticated to be employed by the village processors. Sun drying is still the least expensive method and being the cheapest and simplest means of producing dried and salted fish, it is likely to stay especially with the current energy crisis and economic depression. Therefore efforts are geared towards producing relatively good quality sun-dried fish. Drying should, under the best possible sanitary conditions and the moisture and salt content, be controlled to ensure the stability and quality of the final products.

LITERATURE REVIEW

Sun-dried fish is the result of the removal of moisture by exposure to natural current of air (Anderson and Pederson, 1950). The moisture content in the fish muscle is reduced from about 75% to about 20%. This tradition process is largely dependent on the weather and it is almost impossible to dry fish during the rainy season.

The primary aim in drying fish is to preserve them, that is, to prevent microbial multiplication resulting in spoilage. Fish spoils due to the growth of microorganisms which are moisture dependent; hence on drying a reduction in the microbial load normally occurs.

The moisture and salt content of dried fish can be converted in terms of their water activity using the method of Doe, Curran and Poulter, 1982. Moisture content of dried fish and its water activity are important because they determine the shelf life and the quality of products. The measurement of water activity a_w is useful in order to predict whether a food will be microbiologically stable (Corry, 1975). The microbial stability of dried fish depends upon its a_w which influences the reproduction, metabolic activity and the ability of microorganisms present to survive. Thus a_w is of significance for the propagation and survival of spoilage organisms, which directly affect the quality, stability and safety of the products (Leistner and Rodel, 1975).

In Malaysia dried-salted fish and fishery products constitute about 12% of the total amount of fish processed (Malaysia, Ministry of Agriculture, 1981); hence a survey on the salt and moisture contents was necessary to determine the quality and to improve the present practices in sun drying of fish.

This paper presents the results of a study conducted to determine the salt and moisture content of dried fish and fishery products. The a_w of these products obtained from their water and salt content using the table developed by Doe, Currant and Poulter, is also presented.

AVAILABILITY OF SUPPLY

In 1980, the availability of marine and cultured fish in Peninsular Malysia increased by 9% over the 1979 figures. The total landing in 1980 was 623 898 t (Malaysia, Ministry of Agriculture, 1981). From the above figure 12% was dried, salted and smoked, while the balance was disposed of either fresh or processed into boilde fish, fermented fish and as fish meal. As shown in Figure 1, dried-salted fish is an important industry in Malaysia.

Table 1

Disposition of marine fish landing, 1980

Disposition channel	Weight in t	% used
Fresh fish	377 169	60.4
Salted-dried/smoked	77 240	12.4
Steamed/boiled	7 993	1.3
Fermented	8 922	1.4
Disposed for reduction	131 928	21.2
Disposed for others	20 646	3.3
Total	623 898	100 %

Source: adapted from Malaysia, Ministry of Agriculture (1981)

THE SURVEY

The survey was conducted on shops and markets in Kuala Lumpur and Kajang. The latter is about 30 km away from Kuala Lumpur city. Dried fish and fishery products from these areas were purchased for the study. The fish were grouped into different categories, that is (1) large fish which weigh 600 g and above per fish, (2) medium fish which weigh between 50 to 600 g, (3) small fish which weigh less than 50 g and (4) other fishery products such as dried prawns, oyster and squid.

METHODS

Moisture and salt content from each sample were determined by the AOAC (1970) method and the average values for each kind of fish were recorded. The fact contents on a wet weight basis were taken from available data (Siong, 1982). In addition data from unpublished IDRC work (1982) on fat content of dried fish was used. Water activity a_w

was calculated from the moisture, salt and fat contents and read directly from Annexe I developed by Doe, Curran and Poulter (1982).

Therefore, M_b the fat-free, salt-free, dry matter is:

$$M_b = 100\% - M_w - M_s - M_f$$

where M_w is the mass of water, M_s is the mass of salt and M_f is the mass of fat on a wet weight basis.

Hence, the moisture content on fat-free, salt-free, dry matter basis is: M_w/M_b.

The salt content on fat-free, salt-free, dry matter basis is: M_s/M_b.

Therefore a_w can be read from Table 1 using M_w/M_b and M_s/M_b.

Subjective Evaluation

Evaluation of the comparative appearance of dried fish was also done using subjective tests.

RESULTS AND DISCUSSION

The results of moisture contents, salt contents, fat contents and a_w of dried fish and fishery products were tabulated as shown in Table 2.

Table 2

Moisture content, salt content, fat content and a_w of dried fish and fishery products

Size	Type of fish	Local name	% moisture	% salt	% fat	a_w
Big	Red snapper	Merah	32.9	20.0	3.0	0.75
	Threadfin	Kurau	39.5	23.5	2.5	0.75
Medium	Jewfish	Gelama	41.5	17.0	3.1	0.75
	Chubb mackerel	Kembong	35.5	17.5	3.5	0.75
	Mardtail scad	Cincaru	36.0	21.0	5.0	0.75
	Snakeskin gourami	Sepat Siam	34.0	14.0	4.6	0.75
	Catfish	Duri	24.0	19.5	2.8	0.74
	Finlet scad	Selar	35.0	23.0	3.8	0.75
Small	White pomfret	Bawal Putih	14.0	25.0	3.0	0.67
	Round herring	Tamban	25.0	11.0	3.0	0.73
	Anchovies	Bilis				
	Coarse	Besar	35.0	10.5	7.1	0.78
	Medium	Sedang	26.0	9.5	5.0	0.74
	Small	Kecil	13.0	9.0	3.1	0.56
Other fishery products	Squid	Sotong	21.0	5.0	2.8	0.80
	Prawn	Udang	23.5	7.5	2.3	0.79
	Oyster		11.0	3.0	7.9	0.56

The results show that the moisture contents for large fish (> 600 g), medium fish (50-600 g) small fish (< 50 g) and other fishery products are 33%-40%, 24%-42%, 13%-35% and 11%-24% respectively, while the salt contents are 20%-24%, 14%-23%, 9%-25% and 3%-8% respectively. Figures 1 and 2 show that there is a lowering of moisture and salt content with decreasing size of fish. As shown in Table 3 the water activity a_w for all big and medium dried salted fish is 0.75 (except one medium size fish which gave an a_w value of 0.74).

Table 3

Water activity, a_w, of different sizes of dried salted fish

Size	a_w
Big fish (600 g and above)	0.75
Medium fish (50-600 g)	0.74-0.75
Small (< 50 g)	0.56-0.78
Others (Squid, prawn, oyster)	0.56-0.80

For small fish and other fishery products the a_w ranges from 0.56 to 0.80. The comparative appearance of dried fish is presented in Table 4.

Table 4

Appearance of dried fish

Type of fish	% moisture	% salt	Observation
Red snapper	32.9	20.0	Dry and salt crystals on surface
Jewfish	41.5	17.0	Wet
Chubb mackerel	35.5	17.5	Rancid
Catfish	24.0	19.5	Dry and salt crystals on surface
Snakeskin gouramy	34.0	14.0	Wet
Hardtail scad	36.0	21.0	Wet
Anchovies	35.0	10.1	Wet
Round herring	25	11.0	Dry and brittle

Salting and drying of fish is partly based on the reducing of a_w. Bacteria, yeast and molds associated with dried fish and fishery products frequently cause spoilage. Microbial spoilage takes place if the a_w of the substrate is favourable for the multiplication of the organisms involved and most organisms proliferate at a high a_w (Leistner and Rodel, 1975). Therefore a_w of the products should be reduced and adjusted to improve the storage stability and safety of the products.

CONCLUSION

It was found that most of the salted-dried fish produced in Malaysia is of acceptable quality. The highest moisture content is 42% obtained from dried jewfish, while the lowest salt contents (below 10%) are found in dried anchovies, squid, prawn and oyster.

Table 5 shows the variation of moisture and salt content with size.

Table 5

Range of Moisture and Salt Contents vs Size of Dried Salted Fish

Size	Range of moisture content (%) Min	Max	Range of salt content (%) Min	Max
Big	33	40	20	24
Medium	24	42	14	23
Small	13	35	9	25
Others	11	24	3	8

Due to the popularity of dried salted fish and their relatively high cost, the processor cannot risk high moisture contents to gain weight and shorten the drying time, since moisture and salt content affect storage life and quality of the products. Consumers will not tolerate having to further dry their dried fish after purchasing from the retail shop.

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Annexe I

Water activities from water and salt contents

Salt content (M_s/M_b)

Water content (M_w/M_b)	0	.02	.04	.06	.08	.10	.12	.14	.16	.18	.20	.22	.24	.26	.28	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95	1.0
.02	.04	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.04	.09	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07	.07
.06	.17	.13	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12	.12
.08	.26	.21	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19
.10	.47	.41	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35	.35
.12	.59	.53	.45	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44	.44
.14	.69	.63	.55	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51	.51
.16	.75	.69	.63	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56
.18	.80	.74	.68	.61	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60
.20	.83	.79	.73	.67	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62	.62
.22	.86	.82	.77	.71	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65
.24	.89	.85	.80	.75	.69	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67	.67
.26	.91	.87	.82	.78	.72	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68	.68
.28	.93	.89	.85	.80	.75	.70	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69
.32	.95	.92	.88	.84	.80	.75	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71	.71
.36	.96	.93	.90	.87	.83	.79	.74	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72
.40	.97	.95	.92	.89	.85	.82	.78	.74	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73	.73
.44	.98	.96	.93	.90	.87	.84	.81	.77	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74
.48	.99	.96	.94	.91	.89	.86	.83	.80	.76	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74
.52	.99	.97	.95	.93	.90	.87	.85	.82	.79	.75	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74	.74
.56	1.0	.98	.96	.93	.91	.89	.86	.84	.81	.78	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.60	1.0	.98	.96	.94	.92	.90	.87	.85	.82	.80	.77	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.64	1.0	.98	.96	.94	.93	.90	.88	.86	.84	.81	.79	.76	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.68	1.0	.98	.97	.95	.93	.91	.89	.87	.85	.83	.80	.78	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.72	1.0	.98	.97	.95	.93	.92	.90	.88	.86	.84	.82	.78	.77	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.76	1.0	.99	.97	.96	.94	.92	.90	.89	.87	.85	.83	.81	.79	.76	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.80	1.0	.99	.97	.96	.94	.93	.91	.89	.88	.86	.84	.82	.80	.78	.76	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.84	1.0	.99	.97	.96	.95	.93	.92	.90	.88	.87	.85	.83	.81	.79	.77	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.88	1.0	.99	.98	.96	.95	.93	.92	.90	.89	.87	.86	.84	.82	.80	.79	.76	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.92	1.0	.99	.98	.96	.95	.94	.92	.91	.89	.88	.86	.85	.83	.81	.80	.78	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
.96	1.0	.99	.98	.97	.95	.94	.93	.91	.90	.88	.87	.85	.84	.82	.81	.79	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
1.0	1.0	.99	.98	.97	.96	.94	.93	.92	.90	.89	.88	.86	.85	.83	.82	.80	.76	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
1.5	1.0	.99	.98	.98	.97	.96	.95	.95	.94	.93	.92	.91	.90	.89	.89	.88	.85	.83	.80	.77	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
2.0	1.0	1.0	.99	.98	.98	.97	.97	.96	.96	.95	.94	.94	.93	.92	.92	.91	.89	.88	.86	.84	.82	.80	.78	.76	.75	.75	.75	.75	.75	.75
2.5	1.0	1.0	.99	.99	.98	.98	.97	.97	.96	.96	.96	.95	.95	.94	.94	.93	.92	.90	.89	.88	.87	.85	.83	.82	.80	.78	.77	.75	.75	.75
3.0	1.0	1.0	.99	.99	.99	.98	.98	.97	.97	.97	.96	.96	.96	.95	.95	.94	.93	.92	.91	.90	.89	.88	.86	.85	.84	.83	.81	.80	.79	.77
3.5	1.0	1.0	.99	.99	.99	.98	.98	.98	.98	.97	.97	.96	.96	.96	.96	.95	.94	.93	.92	.92	.91	.90	.89	.88	.87	.86	.84	.83	.82	.81
4.0	1.0	1.0	1.0	.99	.99	.99	.98	.98	.98	.98	.97	.97	.97	.96	.96	.96	.95	.94	.93	.93	.92	.91	.90	.89	.88	.88	.87	.86	.85	.84

COMPARISON OF PRODUCTION COSTS OF SOME DRIED FISH PRODUCTS

by

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ABSTRACT

The paper identifies the various elements in the production costs of the following dried fish products: FPC Type A and B, roller-dried fish, marine beef, artificially and naturally dried fish and fish meat. After identification of the costs going into a product the physical quantities are separated from the prices, making up a formula to compute local production costs, when local unit prices for input factors are put in.

INTRODUCTION

In recent years, an increasing amount of attention has been focused on the fact that a large part of the world's actual and potential fish catches is not used directly for human consumption, but is discarded at sea or used for production of animal feed. One of the main reasons for this is that the species in question are not appreciated as fresh fish, or they may be difficult or costly to make into traditional products. In order to overcome this problem, considerable efforts have gone into development of new products that can be produced from fish that would otherwise not be used for human consumption, particularly the small pelagic species. Examples of such products are FPC type A and B, roller-dried fish, marine beef and salted or dried minces.

The development of these products has taken place in different areas, and the cost of input factors and the general cost structure vary considerably from area to area. There is therefore some confusion concerning the true relative cost comparison between those products and what the product costs would be if the process were to take place in a country other than where it was developed. The objective of this paper is to establish a formula giving a first estimate of the production costs of the products in question in any given area once the local unit costs of the physical input factors are known.

METHOD

The production costs of any given product are determined by the quantity of each physical input factor that goes into the production process and the prevailing local price for each input factor. It is assumed that the required input of physical factors will be fairly constant regardless of where the production will take place geographically, and that these data can be easily obtained from the developer of the process or from the equipment manufacturers. The unit prices of the physical input factors, however, are bound to differ considerably between one geographical area and another and, as a result of this, final production costs for the finished product will also vary considerably.

The method that has been employed in this paper has, therefore, been to identify all the costs that go into a product and then to separate the physical quantities from the prices, thus making up a formula that could be used to compute the local production cost of the product in question once the local unit prices for input factors are put in.

TYPES OF COSTS

The types of costs have been divided into fixed and variable costs, as the fixed costs would have an influence on capacity utilization, whereas the variable costs would not.

Fixed Costs

Land

It is assumed that the real value of land will not change significantly, and that, consequently, no depreciation will be needed. The capital costs of land will thus be the interest rate multiplied by the investment costs in land.

Investment cost in land = i_1

Interest rate = D

Annual cost for land = $C_{F1} = i_1 \cdot D$

Buildings

As buildings deteriorate over the years and have to be replaced, both interest and depreciation will accrue to them as a fixed cost.

Investment in buildings = i_2

Interest rate = D

Depreciation rate = d_2

Annual cost for buildings = $C_{F2} = i_2 \cdot d_2 + \frac{i_2 D}{2}$

It is here assumed that depreciation is linear and that the amount of capital tied up in buildings will decline as depreciation takes effect, so that on the average interest should be charged on half the invested amount of capital (NB: actual interest costs will be high in the initial years and decline progressively over the life of the investment. On the other hand, true maintenance cost will probably increase. However, for the purpose of this paper, it has been assumed that maintenance cost is a function of capacity utilization and should thus be treated as a variable cost).

Machinery and other processing equipment

In calculating the costs for machinery and other processing equipment the same principles would apply as for buildings. The depreciation rates, however, would (probably) be different.

Investment in machinery and other equipment = i_3

Interest rate = D

Depreciation rate = d_3

Annual cost for machinery and other processing equipment = $C_{F3} = i_3 \cdot d_3 + \frac{i_3 D}{2}$

It should be noted that if different rates of depreciation apply to different categories of installations, the costs should be calculated separately for each piece of the installation. Alternatively, equipment with the same rates of depreciation could be grouped together for ease of calculating the annual cost.

Working capital

The working capital necessary for each project will depend on the type of production and also on local conditions. However, a yardstick frequently used is 20%-25% of annual turnover.

Size of working capital = i_4

Interest rate = D

Annual cost of working capital = $C_{F4} = i_4 \cdot D$

Permanent staff

Costs of permanent staff have to be calculated independently in every instance. The principles that should be used for this purpose, however, are to take into consideration all staff costs that are independent of the production level, i.e., all staff costs that would still incur regardless of whether the plant is producing or not in any given moment.

Annual cost of staff = C_{F5}

Taxes

This item refers to taxes that will be incurred regardless of whether the plant is in operation or not, i.e., taxes on land, buildings, share capital, etc., and will have to be calculated separately in every instance, according to the tax laws in function.

Annual cost of taxes = C_{F6}

Other

Other fixed costs that have not been covered in the above paragraphs will have to be calculated separately in every specific situation, i.e., rental, maintenance, insurance, sundries, etc.

Other annual fixed costs = C_{F7}

Variable Costs

Fish raw material

The cost of fish raw material needed to produce one unit of finished product depends on the quantity of fish needed, and the price of landed fish. From this amount we have to deduct the income from sales of by-products and offal in order to calculate the true costs of fish raw material.

Quantity of fish raw material needed = q_{v1}

Price of raw material = p_{v1}

Yield of by products and/or offal = O_{v1}

Price of by products and/or offal = p_{ov1}

Cost of fish raw material = $C_{v1} = q_{v1} \cdot p_{v1} - q_{v1} \; O_{v1} \cdot p_{ov1}$

Other raw materials

The cost of auxiliary raw materials such as salt, ice, solvents, etc., needed to produce one unit of finished product depends on the quantity needed, the yield (i.e., how much product weight that comes out of each unit of raw material weight) and the price. From this we have to deduct the value of the residual raw material that can be recycled or sold, i.e., alcohol, salt, etc.

Quantity of auxiliary raw material needed = q_{v2}

Price of auxiliary raw material = p_{v2}

Yield of residual auxiliary raw material = O_{v2}

Price (or value) of residual auxiliary raw material = p_{ov2}

Cost of auxiliary raw material = $C_{v2} = q_{v2} \cdot p_{v2} - q_{v2} \cdot O_{v2} \cdot p_{ov2}$

Labour

The variable labour cost depends on the man-hours needed to produce one unit of finished product and the wage rate according to level of skill, inclusive of social costs.

Number of man-hours needed = q_{v3}

Wage rate = p_{v3}

Labour cost = $C_{v3} = q_{v3} \cdot p_{v3}$

Fuel

Fuel costs depend on the type and quantity of fuel needed to produce one unit of finished product and the price of fuel.

Quantity of fuel needed = q_{v4}

Price of fuel = p_{v4}

Fuel cost = $C_{v4} = q_{v4} \cdot p_{v4}$

Electricity

Electricity costs depend on the quantity of electricity needed to produce one unit of finished product and the price of electricity.

Quantity of electricity needed = q_{v5}

Price of electricity = p_{v5}

Electricity cost = $C_{v5} = q_{v5} \cdot p_{v5}$

Water

The cost of water depends on the quantity of water needed to produce one unit of finished product and the price of water.

Quantity of water needed = q_{v6}

Price of water = p_{v6}

Water cost = $C_{v6} \cdot p_{v6}$

Packaging material

The cost of packaging material depends on the type(s) and quantity packaging material(s) needed to produce one unit of finished product and the price of packaging material(s).

Quantity of packaging material needed = q_{v7}

Price of packaging material = p_{v7}

Cost of packaging material = $C_{v7} = q_{v7} \cdot p_{v7}$

Taxes

Taxes that constitute a variable cost will have to be calculated in every separate instance. Examples of such taxes are sales tax on turnover, taxes on labour wages that constitute a variable cost, etc.

Tax cost = C_{v8}

Other

Other variable costs will have to be calculated in every separate instance, i.e., transportation, ice.

Other variable costs = C_{v9}

PRODUCT COST PER UNIT

Product cost per unit will equal fixed costs devided by (results of products produced in a year) plus variable unit costs.

Total fixed costs = F

Actual output = 0

Variable costs per unit = V

$$\boxed{\begin{aligned} \text{Product cost per unit} = C &= \frac{F}{0} + V \\ F &= C_{F1} + \ldots\ldots\ldots + C_{F7} \\ V &= C_{V1} + \ldots\ldots\ldots + C_{V9} \end{aligned}}$$

APPLICATION OF THE FORMULA ON PRODUCTION OF FPC, TYPE B IN SENEGAL

General

The information for this example on how the formula can be applied is taken from a paper entitled "Report on the Acceptability Testing of FPC, Type B", by Maria Tagle, published by FAO in 1976.

Fixed Costs

Interest rate

The interest rate when this project was planned constituted 8%. Consequently, D = 0.08.

Land

For this project land was supposed to be donated from the Government. Consequently, $i_1 = 0$.

Buildings

		US$
Production building	=	136 000
Administration building	=	53 800
FPC Storage building	=	109 400
Pier	=	251 400
Total	=	550 600

These calculations were made on the basis of Norwegian construction costs. Construction costs in Senegal were estimated to be 70% of the Norwegian level. Consequently,

i_2 = US$ 385 420

Depreciation rates for buildings are 4%, consequently,

d_2 = 0.04

Machinery and other processing equipment

The needs for machinery and other processing equipment would comprise:

(i)	installation of complete processing equipment composed of coagulator, press, rotadisc drier and evaporator including freight, insurance, assembly, starting-up and running in-costs, totalling	US\$ 1 236 400;
(ii)	laboratory equipment	43 000
(iii)	packaging machinery for 75 g bags	27 400
	Total	US\$ 1 306 800

Consequently, i_3 = US\$ 1 306 800

Depreciation rates for these items are 10%

Consequently, $d_3 = 0.1$

Working capital

The requirement for working capital was in this case put at 25% of annual turnover. Based on a production of 1 000 t/year, this means that i = US\$ 181 500.
$(0.25\ (C_{F1} + C_{F2} + C_{F3} + C_{F5} + C_{F6} + C_{F7} + v\ \ x\ 1\ 000))$

Permanent staff

Due to the nature of the operation, remuneration both to staff and production workers were considered as fixed cost in this case.

Wages to production workers of US\$ 0.72/h	=	US\$ 343 600
Staff salaries	=	27 300
Social costs	=	11 420
Total		US\$ 382 320

Consequently, C_{F5} = US\$ 382 320.

Taxes

No taxes that could be considered as a fixed cost were calculated for this venture, consequently,

$C_{F6} = 0$

Other

Other annual fixed costs calculated for this venture comprise;

Insurance	=	US\$ 43 680
Repairs and maintenance	=	14 600
Shipping costs	=	7 300
Various costs	=	6 400
Total		US\$ 71 980

Consequently, C_{F7} = US\$ 71 980

Variable Costs

Fish raw material

The cost of fish raw material was estimated at US\$ 80/t. Five tons of raw material would give one ton of finished product, resulting in a yield of 20%. As a by-product from the FPC production, there would also be a fish oil production, yielding 6% of raw material weight. The price for fish oil was estimated at US\$ 300/t. Consequently,

q_{v1} = 5

P_{v1} = US$ 80

O_{v1} = 0.06

P_{ov1} = US$ 300

Other raw material

No other raw material is needed in this process, consequently,

C_{v2} = 0

Labour

All labour costs are considered as fixed, consequently,

C_{v3} = 0

Fuel

The quantity of fuel needed to produce one ton of FPC was calculated to 254 litres. Prevailing prices of fuel oil were US$ 0.076/litre. Consequently,

q_{v4} = 254 litres/t

P_{v4} = US$ 0.076/litre

Electricity

The quantity of electricity needed to produce one ton of FPC was calculated at 122 kWh. Prevailing prices of electricity were US$ 0.1/kWh. Consequently,

q_{v5} = 122 kWh

P = US$ 0.1

Water

The quantity of water needed to produce one ton of FPC was calculated to be 0.4 m^3. Fresh water tax was US$ 0.5/m^3. Consequently,

q_{v6} = 0.4 m^3

P_{v6} = US$ 0.5/m^3

Packaging material

Cost of packaging the product into bags, including the cost of the bags, were estimated at US$ 14.6/t. Consequently,

C_{v7} = US$ 14.6/t

Taxes

Apart from water taxes, no taxes that could be classified as variable costs were estimated. Consequently,

C_{v8} = 0

Other variable costs

Other variables costs were estimated as follows:

Landing costs for fish	=	US$ 0.91/t
Ice conservation of raw material	=	4.55/t
Spare parts and laboratory equipment	=	3.05/t
Various other costs	=	1.22/t
Total		US$ 9.73/t

Consequently, C_{v9} = US$ 9.73/t

<u>Total Unit Production Costs</u>

$$F = C_{F1} + C_{F2} + C_{F3} + C_{F4} + C_{F5} + C_{F6} + C_{F7}$$

$$C_{F1} = i_1 D = \text{US\$ } 0 \qquad = \text{US\$}$$

$$C_{F2} = i_2 d_2 + i_2 \frac{D}{2} = \text{US\$ } 385\ 420 \times 0.04 + \frac{550\ 600 \times 0.08}{2} = 30\ 834$$

$$C_{F3} = i_3 d_3 + i_3 \frac{D}{2} = \text{US\$ } 1\ 306\ 800 \times 0.1 + \frac{1\ 306\ 800 \times 0.08}{2} = 182\ 952$$

$$C_{F4} = i_4 D = \text{US\$ } 181\ 500 \times 0.08 = 14\ 520$$

$$C_{F5} = \text{US\$ } 382\ 320 = 382\ 320$$

$$C_{F6} = 0 = 0$$

$$C_{F7} = \text{US\$ } 71\ 980 = 71\ 980$$

$$F = \text{US\$ } 682\ 606$$

$$V = C_{v1} + C_{v2} + C_{v3} + C_{v4} + C_{v5} + C_{v6} + C_{v7} + C_{v8} + C_{v9}$$

$$C_{v1} = q_{v1}P_{v1} - q_{v1}o_{v1}P_{ov1} = \text{US\$ } 5 \times 80 - 5 \times 0.06 \times 300 = \text{US\$ } 310$$

$$C_{v2} = 0 = 0$$

$$C_{v3} = 0 = 0$$

$$C_{v4} = q_{v4}P_{v4} = \text{US\$ } 254 \times 0.076 = 19.3$$

$$C_{v5} = q_{v5}P_{v5} = \text{US\$ } 122 \times 0.1 = 12.2$$

$$C_{v6} = q_{v6}P_{v6} = \text{US\$ } 0.4 \times 0.5 = 0.2$$

$$C_{v7} = \text{US\$ } 14.6 = 14.6$$

$$C_{v8} = 0 = 0$$

$$C_{v9} = \text{US\$ } 9.73 = 9.73$$

$$V = \text{US\$ } 366.03$$

Total production cost per unit (in this case one ton) = $\frac{F}{Q} + V$. This venture was designed to produce up to 3 000 t/year. For alternative production levels of 1 000, 2 000 and 3 000 t/year, the total cost per ton could be:

1 000 t/year = US\$ 1 048 64/t
2 000 t/year = US\$ 707 33/t
3 000 t/year = US\$ 593 56/t

COST COMPARISON BETWEEN VARIOUS MARINE PRODUCTS THAT CAN BE PRODUCED FROM SMALL PELAGIC OR SMALL DEMERSAL SPECIES

General

The weakness in applying the formula on raw data from publications as has been done on FPC, type B in the preceding paragraph is obvious, as the unit costs for investments and other input materials are taken from different countries in different years and represent different price levels. In order to make a cost comparison between different products meaningful, prices for input factors in the production must be comparable and reflect a specific situation at a specific time, and it is the objective of the present paragraph to do so. The products selected for the comparison are FPC, type A and B, roller dried fish, fish meal dried fish and natural dried and smoked fish produced by artificial drying and by natural drying. The data for the physical inputs have been taken from the following publications:

"Acceptability of FPC, type B"
"Marine Protein Concentrate"
"Manufacture of Edible Products by Roller Drying Small Fatty Fishes"
"Production of Dried Fish"
"The Production of Fish Meal and Oil"
(Reference is made to the bibliography for authors and publishing data).

The data for unit prices for physical input factors have been taken from "Feasibility Study for a Pilot/Demonstration Distribution Scheme on Small-Scale Fishermen Catches in the Marantão State", prepared by FAO in 1979 in Brazil.

General Assumptions Made in Preparing the Cost Estimates for the Products to be Compared

The following assumptions have been made in preparing the cost estimates:

(a) all plants will be in production 220 days per year;
(b) cost of fish raw material is a uniform US$ 80/t, regardless of whether the required input is lean or fatty fish;
(c) labour cost are a uniform US$ 0.65/h for unskilled labour;
(d) fuel oil costs are US$ 0.22/litres; or US$ 0.235/kg;
(e) 0.07 tons of fuel oil are required to produce 1 t of steam;
(f) electricity costs are US$ 0.0078/kWh;
(g) pakaging material costs are a uniform US$ 16/t of finished product;
(h) other variable costs (mostly raw materials handling and conservation has been put at a uniform US$ 10/t of finished product;
(i) no costs have been calculated for fish landing facilities;
(j) no costs have been assumed for the land on which to build the factories;
(k) investment costs for building, machinery and processing equipment given in the various papers are brought up to 1978 cost level by adjusting the original costs according to the construction cost index in the country of manufacture;
(l) the interest rate is 12%;
(m) the depreciation rate for buildings is 4%;
(n) the depreciation rate for machinery and processing equipment is 10%;
(o) required working capital is 25% of total processing costs exclusive of working capital;
(p) no taxes have been assumed;
(q) permanent staff will be fairly uniform in factories with comparable capacity;
(r) no shipping costs have been included;
(s) costs for insurance, repairs, maintenance and other fixed costs not specifically included in the calculations have been estimated arbitrarily according to capacity and the size of investment.

Specific Assumptions in Calculating the Costs for FPC, Type B

Apart from the assumptions made in paragraph 4, the following specific assumptions have been made in calculating the costs of FPC, type B:

(a) production capacity is considered to be 2 200 t of finished product per year;
(b) variable labour costs are considered to be 6 men/shift, 6 men/shift x 8 hours/shift x 3 shifts/day x 220 days/year: 2 200/t of FPC-B/year = 14.4 man-hours/t of FPC-B;
(c) costs of permanent staff are considered to be:

1 general manager	= US$ 28 414/year
1 clerk/accountant	= 9 742/year
1 typist/secretary	= 3 653/year
1 mechanic	= 2 436/year
3 foremen	= 12 178/year
2 watchmen	= 2 923/year
Total	= US$ 59 346/year

(d) original costs for investments were compiled in 1975. According to official Norwegian statistics (Economic outlook, 1975-79, Table 55: Wholesale index for durable production goods, published by the Central Bureau of Statistics, Oslo, Norway), investment cost rose 24% from 1975 to 1978. Consequently, all original costs estimates for investments have been multiplied by 1.24;
(e) fixed costs not specifically included in the calculations have been arbitrarily estimated at US$ 60 000/year.

Specific Assumptions in Calculating the Costs of FPC, Type A

(a) Production capacity is considered to be 1 875 t a year of finished product;
(b) 100 000 kg of raw fish is needed to produce 15 000 kg of FPC-A. Consequently, 6.67 kg of raw material are needed to produce 1 kg of finished product.
(c) Consumption of isopropyl alcohol is 227 gallons/24 h. Consequently, consumption of alcohol/t of FPC-A is 227 gallons/24 h x 3.785/gallon: 7.5/t of FPC-A/24 h = 114.6 litres.
(d) Variable labour costs are considered to be 96 hours/24 h. Consequently, 12.8 man-hours are needed to produce 1 t of FPC-A.
(e) Steam consumption is 408 000 lb of steam/24 h. Consequently, the fuel oil consumption is 408 000 lb of steam/24 h x 0.454 kg/lb x 0.001 t/kg: 7.5 t of FPC-A/24 h x 0.07 t of fuel oil/t of steam = 1.729 t of fuel oil/t of FPC-A.
(f) Electricity consumption is 200 kW/h = 4 800 kWh/24 h = 640 kWh/t of FPC-A.
(g) Investment in machinery and processing equipment, as given in the paper are the following:

Purchased equipment costs (as specified in the paper)	= US$ 231 500 (PE)
Equipment installation = 43% of PE	= 99 545
Piping = 36% of PE	= 88 340
Instrumentation = 10% of PE	= 23 150
Physical plant cost (PPC)	= 437 535
Engineering and construction = 20% of PPC	= 87 500
Direct plant cost (DPC)	= 525 035
Contractor's fee = 7% of DPC	= 36 752
Contingency = 10% of DPC	= 52 503
Fixed capital (IF)	= US$ 614 290

(h) Invest in buildings, as given in the paper, are the following:

Production building = 40% of PE	= US$ 92 600
Fish storage	= 7 000
Physical plant costs	= 99 600
Engineering and construction = 20% of PEC	= 19 920
Direct plant cost (DPC)	= 119 520
Contractor's fee = 7% of DPC	= 8 366
Contingency = 10% of DPC	= 11 952
Fixed capital (IF)	= US$ 139 838

(i) The investment cost figures given in the paper are based on 1965 costs. According to the official statistics of the USA (Statistical Abstract of the United States, 1979, published by the U.S. Department of Commerce, Table 784: Producer price indexes by stage of processing - materials and components for construction), construction costs from 1965 to 1978 increased 133%. Consequently, the investment costs adjusted for inflation should be the following:

Buildings = US$ 139 838 x 2.33 = US$ 325 823
Machinery and processing equipment = US$ 614 290 x 2.33 = US$ 1 431 295

(j) Permanent staff are assumed to be of the same size as for the FPC-B factory, as the two plants will have the same annual capacity measured in raw material intake, and the processes, apart from cleaning the semi-finished product with alcohol in the case of FPC-A, are roughly identical.
(k) Other fixed costs, not specifically included in the calculation, are estimated to be the same as for FPC-B, i.e., US$ 60 000 annually.

Specific Assumptions in Calculating the Costs of Marine Beef

(a) Production capacity is 245 kg/h of finished product 0.245 t of marine beef per hour x 24 hours/day x 220 days/year = 1 294 t of marine beef per year.
(b) 5 t of whole, raw fish yield 1.75 t of minced fish, which again yields 0.245 t of marine beef. Consequently, 20.4 t of raw fish is needed to produce 1 t of finished product.
(c) As 5 t of whole, raw fish yields 1.75 t of mince, it also presumably yields 3.25 t of offal. 3.25 : 5 = 0.65 yield of offal from raw material.
(d) It is assumed that offal can be sold at a price of US$ 40/t as raw material for fish meal, silage, etc.
(e) As a by-product from the marine beef production, there would also be a fish oil production, yielding 15% of raw material weight. The price for fish oil was estimated at US$ 300/t.
(f) 4.08 h is needed to produce 1 t of finished product. Consumption of alcohol is 50 litres/h. Consequently, 50 litres/h x 4.08 h/t of marine beef = 204 litre/t of marine beef.
(g) Other required additives to production of marine beef are sodium bicarbonate and sodium chloride. The required quantities of these products are not given in the paper, but costs are put at yen 2 500/h. Consequently, costs per ton of marine beef are yen 10.200 = US$ 49.04 (US$ 1.00 = yen 208).
(h) Processing costs in the paper assumes input of fish mince. In order to transform whole fish to mince, it is assumed that one would need 3x Baader 33 for preparation of small fish for bone separation and 1x Baader 695 bone separator.
(i) The required number of machine operators would be 2 x 3 for Baader 33, 1 x 1 for Baader 695 and 2 x 1 for the marine beef production unit. This gives a total of nine workers. 9 men x 4.08 h/t of marine beef = 36.72 man-hours per t of marine beef.
(j) 7 t of steam per hour is required in the production; 7 t of steam/h x 4.08 h/t of marine beef x 0.07 t of fuel oil of steam = 2.2 t of fuel oil per ton of marine beef.
(k) Baader 33 requires 2.2 kW electricity per hour; Baader 695 requires 4.4 kW electricity per hour. The marine beef production unit requires 600 kW electricity per hour
[(2.2 kW x 3) + 4.4 kW + 600 kW)] x 4.08 h/t of marine beef = 2 493 kWh/t of marine beef.
(l) One Baader 33 needs 1.3 m^3 of water per hour of operation; 1.3 m^3/h x 3 x 4.08 h/t of marine beef = 15.9 m^3 of water per ton of marine beef.
(m) Investment costs given in the paper refer to Japan in 1978. No updating of costs by construction prices indexes is deemed necessary.
(n) No costs for buildings are given in the paper. It would be reasonable to assume that an operation of this nature would require at least the same size of buildings as FPC types A and B. Building costs are, therefore, assumed to be US$ 350 000 for calculation purposes.
(o) Costs of three Baader 33 for preparation of small fish for bone separation are considered to be 3 x D.M. (79 000 + 3 000) x US$ 0.51/D.M. = US$ 126.154.
(p) Cost of one Baader 695 bone separator and spare parts is considered to be D.M 79 000 x US$ 0.51/D.M. = US$ 40 513.

(q) Cost of one marine beef production unit is considered to be yen 1 070 million: yen 208/US$ = 5 144 231.
(r) Permanent staff is assumed to be equal to FPC type B.
(s) Other fixed costs not specifically mentioned in the calculation are arbitrarily assumed to be US$ 90 000 per year (50% higher than FPC-A and B) as marine beef production is considered to be more technically complex than FPC production.

Specific Assumption in Calculating the Costs of Roller-Dried Fish

(a) Production capacity is 210 t of finished product with 200 x 8 working hours, or 231 t with 220 working days.
(b) 1 t RDF comes from 5 t minced fish and minced fish is 60% of whole fish. Consequently, 8.33 t of raw fish is needed to produce 1 t RDF.
(c) It is assumed that 0.40 yield of offal from raw fish can be sold at a price of US$ 40/t as raw material for fish meal, silage, etc.
(d) Electricity consumption is US$ 12.5/t RDF.
(e) Steam consumption depends on the amount of water evaporated from the fish and it is estimated to be about 1.2 kg steam/kg water vapourized industrially. That means, to dry fish 5 t to 1 t day product, steam consumption should be 4.8 t steam or 0.336 t of oil.
(f) Water consumption is US$ 19.5/t RDF.
(g) Permanent staff is estimated to be:

1 foreman/manager	US$ 4 059/year
1 mechanic	2 436/year
Total	US$ 6 495/year

(h) Seven workers are needed in the production of RDF1/
(i) As the paper was published in the last half of 1978, no correction of the costs based on indexation is considered necessary.
(j) Building costs are assumed to be about 75% of FPC type A building costs. Consequently, building costs are US$ 25 000.
(k) Investment in machinery and other processing equipment is estimated at US$ 185 640.
(l) Other fixed costs not specifically included in the calculations have arbitrarily been estimated at US$ 15 000.

Specific Assumption in Calculating the Costs of Mechanically and Naturally Dried Fish

(a) Production capacity for both mechanically and naturally dried fish is 46.6 t/year of finished product = 0.212 kg a day with 220 days of production per year.
(b) The yield in both methods of production is 31%. Consequently, 3.23 t of raw material are needed to produce 1 t of finished product.
(c) No saleable waste results from the production process.
(d) 36 kWh per day is required for mechanical drying; 36 kWh/day: 0.212 t of DF/day = 170 kWh/t of mechanically dried fish.
(e) No electricity is needed for the production of naturally dried fish.
(f) 84 litres of fuel oil is needed for one day of production of mechanically dried fish. 84 litres/day: 0.212 t of DF/day = 396 litres of fuel oil per ton of mechanically dried fish.
(g) No fuel oil is needed for the production of naturally dried fish.
(h) Five workers are needed in the production of mechanically dried fish. 5 men x 12 h/day: 0.212 t of DF/day = 283 man-hours/t of mechanically dried fish.
(i) Ten workers are needed in the production of naturally dried fish. 10 men x 12 h/day: 0.212 t of DF/day = 377 man-hours/t of naturally dry fish.
(j) The investment costs given in the paper are based on 1975 figures. To correct for inflation between 1975 and 1978 the same correction factor has been used as for FPC, type B (i.e., assuming an inflation of 24% in the period).
(k) Costs for store and processing buildings for mechanical drying are estimated to be (US$ 1 500 + US$ 7 500) x 1.24 = US$ 11 160.
(l) Costs for store and processing buildings for natural drying are estimated to be (US$ 1 500 + US$ 759) x 1.24 = US$ 2 790.

1/ 7 men x 8 h/day: 1.05 t of DF/day = 53.3 man-hours per ton of RDF

(m) The required machinery and other processing equipment for mechanical drying is considered to be a mechanized drier plus miscellaneous equipment and contingencies. The costs for these installations should be (US$ 9 000 + US$ 1 500) x 1.24 = US$ 13 020.
(n) Investment costs for drying racks for natural drying are estimated to be US$ 720 x 1.24 = US$ 893.
(o) The depreciation rate for drying racks for natural drying is estimated to be 100% annually.
(p) Investment in miscellaneous equipment and contingencies for natural drying is estimated to be US$ 1 230 x 1.24 = US$ 1 525.
(q) The depreciation rate for miscellaneous equipment and contingencies is considered to be 10% annually.
(r) Permanent staff for mechanical is estimated to be:

1 foreman/manager	US$ 4 059/year
3 watchmen	4 385/year
Total	US$ 8 444/year

(s) Permanent staff for natural drying is estimated to be

1 foreman/manager	US$ 4 059/year
2 watchmen	2 924/year
Total	US$ 6 983/year

(t) Other fixed costs not specifically included in the calculations have arbitrarily been estimated at US$ 2 000/year, both for mechanical and natural drying. The figure reflects the much lower capacity and investment volume for dried fish than for the other products discussed in this paper.

Specific Assumptions in Calculating the Costs of Fish Meal

(a) Production capacity is 66.7 t of raw fish per day and the yield is 25% of raw fish. Consequently, production capacity is 3 667 t/220 days.
(b) No saleable waste results from the production process.
(c) Fish cost is assumed to be US$ 80/t for comparison while the actual cost is about US$ 40/t.
(d) Fuel consumption is 50 kg/t of fish, or 200 kg/t of fish meal.
(e) Electricity consumption is assumed to be US$ 2 per ton of fish or US$ 8 per ton of fish meal.
(f) Water consumption is US$ 0.10 per ton of fish, or US$ 0.4 per ton of fish meal.
(g) Labour cost is given as US$ 1 per ton of fish, or US$ 4 per ton of fish meal.
(h) Permanent staff costs are US$ 75 000 per year.
(i) The investment costs given in the paper are based on 1975 figures. To correct for inflation between 1975 and 1978 the same correction factor has been used as for FPC, type B.
(j) Costs for plant buildings, office, workshop and storage are US$ 70 000 x 1.24 = US$ 86 800.
(k) Costs for plant machinery, freight, insurance and installation and miscellaneous equipment are US$ 580 000 x 1.24 = 719 200.
(l) Other fixed costs not specifically included in the calculations have arbitrarily been estimated at US$ 60 000/year.

Specific Assumptions in Calculating the Costs of Natural Dried and Smoked Fish

(a) Daily capacity is 4.3 t of raw fish with 27% yield. Consequently production capacity is 255 t of dry fish per 220 days.
(b) No saleable waste results from the production process.
(c) The process needs 430 kg of salt per day or 371 kg per ton dry fish. The cost of salt is US$ 182/t. Consequently, the salt cost is US$ 67.47 per ton of dry fish.
(d) Wood is used in the process 3 m^3/day. The cost is estimated to be US$ 3.9 per ton of dry fish.
(e) 15 direct labourers with seven work hours are used per day.
(f) Permanent staff is estimated to be:

1 plant supervisor	US$ 4 059
1 foreman	3 653
1 clerk/storekeeper	2 436
10 permanent labourers	14 620
Total	US$ 24 768

(g) The investment costs given in the paper are based on 1975 figures. To correct for inflation between 1975 and 1978 the same correction factor has been used as for FPC, type B.

(h) Construction of drying and smoking plants is US$ 22 000 x 1.24 = US$ 27 280.

(i) Equipment cost (scales, sealing machine, generator, water pump, miscellaneous) is US$ 8 000 x 1.24 = US$ 9 920.

(j) Other fixed costs not specifically included in the calculations have arbitrarily been estimated at US$ 10 000/year.

Cost Comparison between the Various Products Discussed in this Paper

Using the formula for cost calculation and applying the assumptions listed in the previous paper, the results can be tabulated as shown in Table 1.

DISCUSSION

Comparison between the Relative Production Costs

In comparing the relative production costs of the products covered in this study, the following points should be made:

(a) FPC, type A and marine beef are made basically by the same principle, solvent extraction, but the marine beef process is somewhat more complex. Both processes are very expensive and marine beef is the most expensive product in this study. However, marine beef is still cheaper than real beef or other meat and the percentage of protein is much higher. The variable costs of marine beef and FPC type A are comparable, but the fixed costs of marine beef are three times of the fixed costs of FPC type A. This is the result of higher equipment costs with lower output. The equipment cost is 4.7 times of FPC type A's. While the input of raw fish is twice, the output is only 0.78 of FPC type A's. Marine beef process needs three times as much fish of FPC type A process because only the flesh is used to make marine beef. However, the fish cost of marine beef is not so high since there is by-product income. One thing that makes both processes more expensive than the other is the cost of the other raw materials. Although there are recovery processes for these raw materials, the cost is still high. Another point is the energy consumption which is much higher than the other. The labour intensity in marine beef process is probably for preparing the fish. However, variability of labour costs does not affect the total cost much. Raw material costs, working days and energy costs are the main indications of the cost of marine beef and FPC type A. One would, however, note that FPC type A can be made with different processes and their costs should be changed.

(b) At this time, the roller-dried fish (RDF) is not produced in industrial scale, only experiment has been carried out with laboratory and/or pilot scale equipment. But a factory in Esberg, Denmark, is going to produce RDF soon. The information used in this paper was adapted from J. Nielsen's report. In her experiment, fatty fish was used together with maize to solve the oil problem of fatty fish. The normal RDF uses lean fish as raw material only. So, assumptions and correction had to be made to get the normal RDF cost. According to the paper, the working time was eight hours per day. This could be increased to 24 hours per day since it is continuous process. The total cost would be reduced significantly and more over if the production was sealed up to say, about 2 000 t of RDF per year. Fish cost is the main cost of the process. Like marine beef, the process uses the flesh of fish only, this gives a labour intensive process with high fish costs. But it will give a product of good colour (off-white) and in flake form, which is the advantage of RDF.

Table 1

	FPC type B	FPC type A	RDF	Marine Beef	Mechanically Dried Fish	Naturally Dried Fish	Fish Meal	Nat.Dried & Smoked Fish
Fish/day	50 tons	50 tons	8.7 tons	100 tons	0,684 tons	0.684 tons	66.7 tons	4.3 tons
Product Capacity	2 220 t/ 220 days 24 h	1 650 t/ 220 days 24 h	231 t/ 220 days 8 h	1 294 t/ 220 days 24 h	46.6 t/ 220 days 12 h	46.6 t/ 220 days 12 h	36.67 t/ 220 days 24 h	255 t/ 220 days 24 h
Fixed Cost (US$/yr)								
Land	-	-	-	-	-	-	-	-
Buildings	47 800	32 600	25 000	35 000	1 116	279	8 680	2 728
Equipment	259 264	228 990	29 702	849 760	2 083	1 191	115 072	1 587.2
Working Capital	41 797	67 805	7 171	76 014	1 205	1 226	52 357	4 704
Permanent Staff	59 346	59 346	6 495	59 346	8 444	6 983	75 000	24 768
Taxes	-	-	-	-	-	-	-	-
Other	60 000	60 000	15 000	90 000	2 000	2 000	60 000	10 000
Total Fixed Costs	468 207	448 741	83 368	1 110 120	14 848	11 679	311 109	43 787.2
TFC/t	212.82	271.96	360.9	857.90	318.63	250.6	84.8	171.71
Variable Cost (US$/t)								
Fish	5* 310	6.67*533.6	8.33*533.34	20.4*183.6	3.23*258.4	3.23*258.4	4* 320	3.7*296
Other Raw Material	-	114.6	-	253.04	-	-	-	67.47
Labour	9.36	8.32	34.64	23.86	184	386	4	68.75
Fuel oil	70.5	406.3	78.96	470	87.12	-	47	3.90
Electricity	23.4	49.9	12.5	194.5	13.3	-	8	-
Water	0.2	0.2	19.5	7.95	-	-	0.4	-
Packaging Material	16	16	16	16	16	16	16	16
Taxes	-	-	-	-	-	-	-	-
Other	10	10	10	10	10	10	10	10
Total Variable Costs	439.46	1 138.92	704.94	1 158.95	568.82	652.4	405.4	461.52
Total Cost/t	652.28	1 410.88	1 065.84	2 016.85	887.45	903	490.2	633.33
			(825.24 with 24 h)		(728.14 with 24 h)			
Fixed Costs	32.8%	19.3%	28.8%	42.5%	35.9%	27.8%	17.3%	27.1%
Raw Material Costs	47.4%	45.9%	50.0%	21.6%	29.1%	28.6%	25.3%	46.7%
Other Variable Costs	19.8%	34.8%	21.2%	25.9%	35.0%	43.6%	17.4%	26.2%

*tons of raw fish/ton of dried product

(continued)

Table 1 (continued)

	FPC type B	FPC type A	RDF	Marine Beef	Mechanically Dried Fish	Naturally Dried Fish	Fish Meal	Nat.Dried & Smoked Fish
100 days' operation	891.85	1 696.24	1 473.54	3 005.16	1 248.73	1 179.83	577.44	822.50
200 days' operation	672.25	1 434.66	1 099.82	2 099.44	917.31	925.90	497.50	648.98
300 days' operation	599.04	1 347.47	975.24	1 797.53	806.83	841.26	470.86	591.15
Fish cost increase 10%	693.48	1 465.84	1 067.44	2 184 94	914.05	929.63	523.20	663.82
Fish cost increase 50%	858.28	1 685.69	1 340.51	2 857.33	1 020.51	1 036.09	638.11	785.77
Fish cost increase 100%	1 064.28	1 960.49	1 615.18	3 697.81	1 153.59	1 169.17	819.84	938.21
Fuel & Electricity & Water cost increase 10%	661.97	1 457.89	1 077.27	2 086.10	897.78	903	495.95	633.72
Fuel & Electricity & Water cost increase 50%	700.74	1 645.93	1 123	2 363.16	939.14	903	518.77	635.33
Fuel & Electricity & Water cost increase 100%	749.20	1 880.98	1 180.13	2 709.47	990.87	903	547.30	637.23
Labour cost increase 50%	657.1	1 415	1 083.68	2 028.78	982.20	1 092.53	492.2	668.48
Labour cost decrease 50%	647.6	1 406.72	1 048	2 004.92	792.68	713.49	488.2	598.19

(c) FPC, type B and fish meal are made in much the same way. So, fish meal costs are given for comparison even though it is not for human consumption. The full capacity of the fish meal plant in the paper, is 100 t of raw material per day, but working at two thirds of its capacity. It is proved that with hygenic design of buildings and equipment, FPC type B process needs fixed costs much higher than fish meal process. This yield is also reduced. By assuming the same fish cost, the variable costs are about the same. Fish cost is the main cost of the process. FPC, type B needs a greater amount of fish but its cost was reduced by the by-product income. The labour costs of both processes are low, reflecting the degree of automation. It is interesting that the energy consumption is very low compared with FPC, type A and marine beef. The energy and labour cost of FPC, type B is somewhat higher than fish meal. This may be because of hygienic design of the process and the higher amount of raw material. Anyhow, FPC, type B is the cheapest non-tradition product from fish.

(d) Mechanical and natural dried fish are traditional product. These products are highly labour intensive and with high wages their costs are very high. By decreasing the labour cost 50%, the costs are lowered considerably. The fixed cost of mechanical dried fish is quite high because of low capacity. The capacity may be increased by working 24 hours a day. However, it is impossible for natural dried fish process to work all day or all year round. Natural drying and mechanical drying process can be combined with good results since this increases the production capacity and reduces both labour and energy costs. Natural dried and smoked fish is an example of this mixing process. Its cost is quite low even using the same wage rate.

(e) It should be stated again that the results of the comparison are valid only with the conditions given and for the specified processes. With different methods of processing or equipment or conditions, the results will be changed. Information collected from publications is rarely complete and so one should attempt to get real costs from processors or equipment manufacturers. This paper aims only to give the formula of calculating production costs for different products. A further point is that one cannot determine the economic feasibility of a product only from the production costs. A number of other factors such as acceptability, access to markets and availability of raw material will contribute to the eventual success of failure.

APPENDIX 1

Key to the Mathematical Symbols that are Used in the Formula

Fixed Costs

D = Interest rate
C_{F1} = Annual cost for land
  i_1 = Investment cost in land
C_{F2} = Annual cost of buildings
  i_2 = Investment cost for buildings
  d_2 = Depreciation rate for buildings
C_{F3} = Annual cost for machinery and other processing equipment
  i_3 = Investment in machinery and other processing equipment
  d_3 = Depreciation rate for machinery and other processing equipment
C_{F4} = Annual cost of working capital
  i_4 = Size of working capital
C_{F5} = Annual cost of permanent staff
C_{F6} = Annual cost of taxes
C_{F7} = Other annual fixed costs

Variable Costs (all costs per unit of finished product)

C_{v1} = Cost of fish raw material
  q_{v1} = Quantity of fish raw material needed
  p_{v1} = Price of fish raw material
  O_{v1} = Yield of by-products and/or offal
  P_{ov1} = Price of by-products and/or offal
C_{v2} = Cost of auxiliary raw material
  q_{v2} = Quantity of auxiliary raw material needed
  P_{v2} = Price of auxiliary raw material
  O_{v2} = Yield of residual auxiliary raw material
  P_{ov2} = Price (or value) of residual auxiliary raw material
C_{v3} = Labour costs
  q_{v3} = Number of man-hours needed
  P_{v3} = Wage rate
C_{v4} = Fuel costs
  q_{v4} = Quantity of fuel needed
  P_{v4} = Price of fuel
C_{v5} = Electricity costs
  q_{v5} = Quantity of electricity needed
  P_{v5} = Price of electricity
C_{v6} = Water costs
  q_{v6} = Quantity of water needed
  P_{v6} = Price of water
C_{v7} = Cost of packaging material
  q_{v7} = Quantity of packaging material needed
  P_{v7} = Price of packaging material
C_{v8} = Taxes
C_{v9} = Other variable costs

Other

C = Product cost per unit F = Total fixed costs O = Actual output

APPENDIX 2

Questionnaire for Collection of the Information to be Applied in the Formula

It is often practical to have a uniform questionnaire for data collection when different production processes in different areas are to be compared. When the information has been obtained in a uniform way, it is easier not only to compare the total production costs, but also the underlying assumptions and the individual cost factors for their calculation. For the formula presented in this paper, the following information would be necessary:

(a) Fixed Costs

Type of cost	Information needed					Annual fixed cost
Land	Size of plot	Cost per m^2	Site prep. Investment in land	Interest rate		Annual cost of land
Buildings	Size of buildings	Cost per m^2 or m^3	Investment in buildings	Interest rate	Depreciation rate	Annual cost of buildings
Machinery and other processing equipment	Description of process and items needed	Cost per item	Investment in machinery & other proc.equip.	Interest rate	Depreciation rate	Annual cost of machinery and other processing equipment
Working capital	Size of turnover	Working capital req'ts as % of turnover	Investment in working capital	Interest rate		Annual cost of working capital
Staff	Number & kind of staff	Salaries for each category				Annual cost of staff
Taxes	Kind of taxes	Tax Rates				Annual cost of taxes
Other	Kind of costs	Rates				Other Annual fixe[d] costs

Remarks: 1. Capacity ________________ tons of dry product/year
2. Actual Output ________________ tons of dry product/_____ days

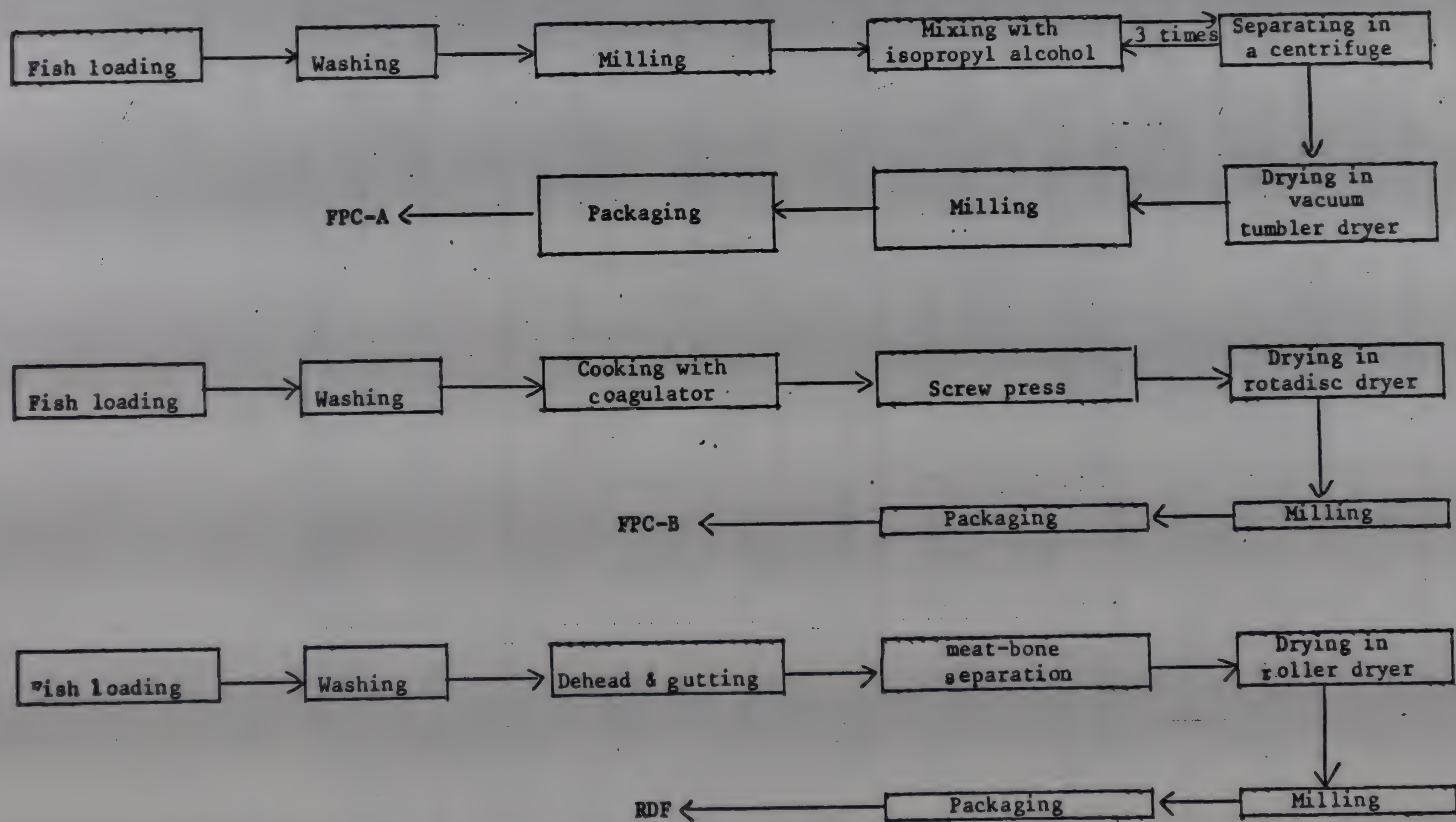
(b) Variable Costs (always given in the quantity needed to produce one unit of finished product, i.e., ton)

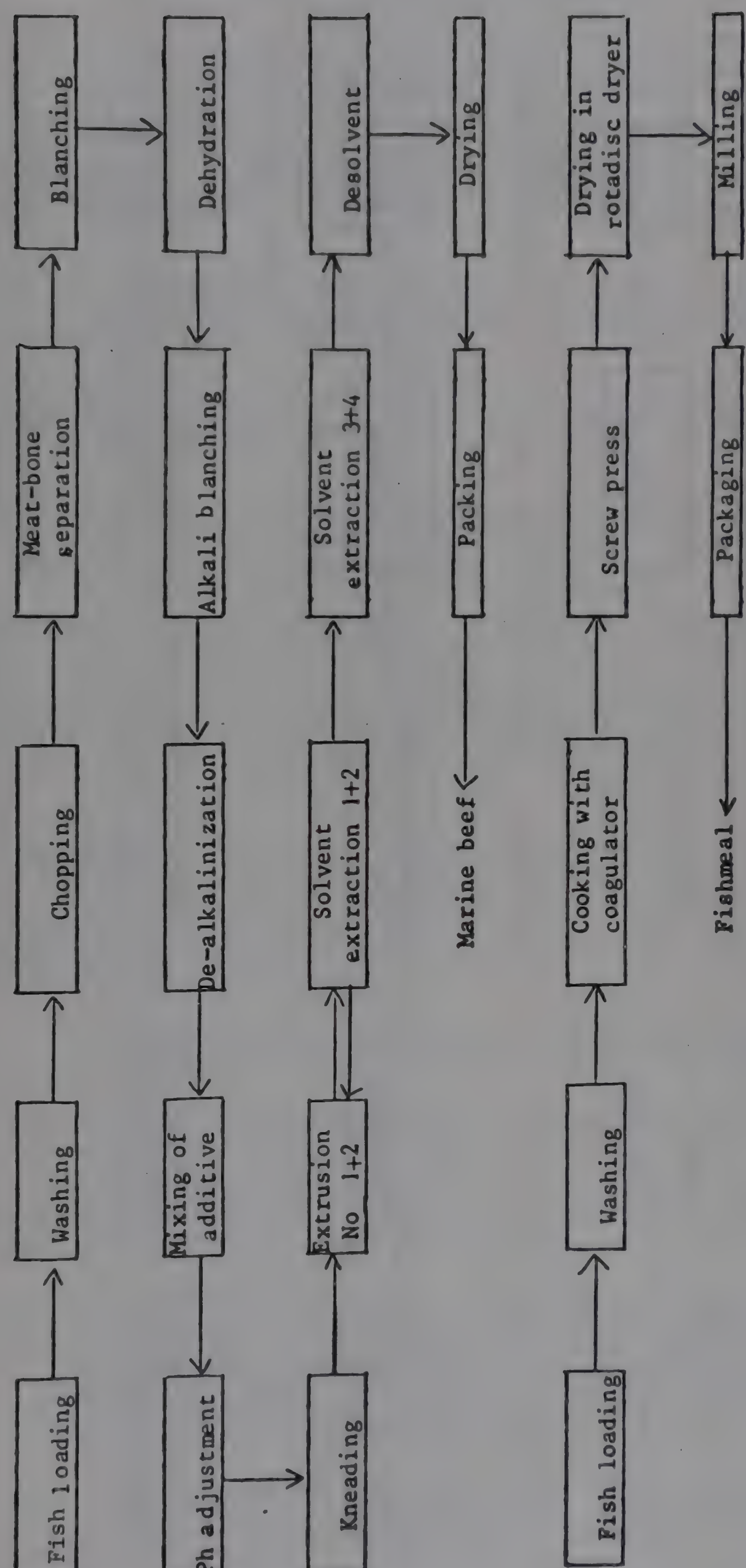
Type of cost	Information needed				Cost per unit of finished product
Fish raw material	Quantity of raw material	Price of raw material	Yielf of offal and/or by-products	Price of offal and/or by-products	Cost of fish raw material
Auxiliary raw material	Kinds and quantity of raw materials	Prices of raw materials	Yield of offal and/or by-products	Price/value of offal and/or by-products	Cost of auxiliary raw material
Labour	Classes and number of man-hours	Wage Rates			Labour cost
Fuel	Types and quantity of fuel	Fuel Prices			Fuel cost
Electricity	Quantity of electricity	Electricity price			Electricity cost
Water	Quantity of water	Water price			Water cost
Packaging material	Quantity of packaging material	Price of packaging material			Packaging material cost
Taxes	Kind of tax	Tax Rates			Tax cost
Other	Kind of costs	Rates			Other costs
					Total variable costs

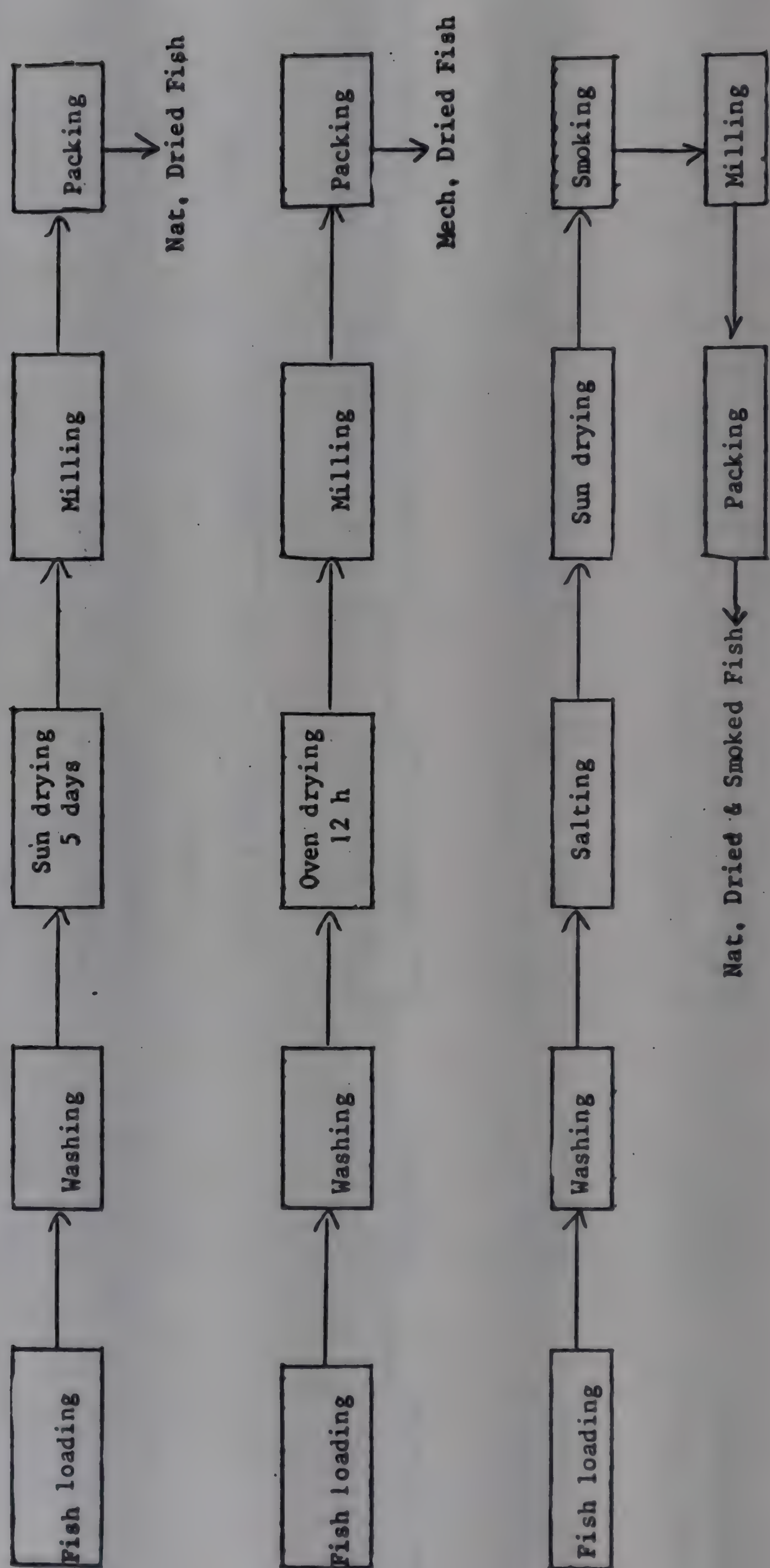
Remarks: 1. Price at the factory or ______________
2. Days of operation ______________ days a year

APPENDIX 3

Flow Diagram of Drying Processes in the Paper




Fish loading
Washing
Chopping
Meat-bone separation
Blanching
Dehydration
Alkali blanching
De-alkalinization
Mixing of additive
Ph adjustment
Kneading
Extrusion No 1+2
Solvent extraction 1+2
Solvent extraction 3+4
Desolvent
Drying
Packing
Marine beef
Fish loading
Washing
Cooking with coagulator
Screw press
Drying in rotadisc dryer
Milling
Packaging
Fishmeal


Fish loading
Washing
Sun drying
5 days
Milling
Packing
Nat. Dried Fish
Fish loading
Washing
Oven drying
12 h
Milling
Packing
Mech. Dried Fish
Fish loading
Washing
Salting
Sun drying
Smoking
Milling
Packing
Nat. Dried & Smoked Fish

APPENDIX 4

Indicative Parameters of Processing Costs

(a) Land and building: the size of land and building needed increases with the capacity of the plant but not in a linear manner since the actual plant takes up a relatively small proportion of the total area. The remainder is taken up by storage space for raw materials and end-products, ancillary activities, such as preparation and packing, and office space. In terms of building area a small to medium plant and ancillary activities may occupy only 200-300 m^2 but the whole operation may need a site from 500-800 m^2, the additional space being needed mainly for storage. However, one should think about expanding the factory too.

Different sorts of processes have very different requirements, a fish meal plant needs relatively little space since no hand operations are involved; natural dried fish process, however, needs relatively much more space.

Land cost depends on its site. A suitable site should be selected even if it is quite expensive; if land can often be rented it will lower other costs such as transportation.

Building costs vary widely according to material and specifications but, as a general guideline, building costs between US$ 100 and US$ 150/m^2 are currently about average. Where conditions are difficult a hiher figure may be needed.

It is readily apparent that the small plant, if housed in a building of generally accepted standards, is at a considerable disadvantage in relation to larger plant capacities if it has to bear the full cost of building. It is, therefore, a considerable advantage if developing countries can obtain concessionary terms for such investment, particularly when it is remembered that the market, open to a young industry, often needs developing and that, therefore, a relatively small initial plant capacity may be appropriate.

(b) The plant and equipment: this is generally the most expensive single item of expenditure. While precise costs depend very much on plant size and the degree of mechanization. The smallest fish meal line processing about 2 t of raw material in 8-hour shifts now costs in the region US$ 200 000 which rises to around US$ 800 000 for a plant processing 20 t in an 8-hour shift, an amount in excess of US$ 2 million might be needed for a plant handling 200 t in a shift.

The costs also depend on the process and the degree of hygienic design. This has been shown in the comparison between FPC type A, FPC type B and fish meal.

There are additions to the ex-works plant costs; allowance has to be made for costs incurred up to the time the plant is commissioned. Most obvious items are the erection and installation costs, freight and insurance. As a general rule of thumb, these charges, these charges, including pre-production trials and an allowance for spare parts and supervision fees, may be calculated at 10-12% of the capital cost.

Freight and insurance charges can vary widely depending on volume, weight and destination of the goods transported but for illustrative purposes a conservative figure of 20% of the value of the goods may be used. Taxes and duties obviously vary greatly and can be severe on certain items of equipment. Concessions are sometimes given for items provided within official aid programmes. It is usual to include a contingency sum of 10% of the estimated capital cost in any provision budget.

(c) Other fixed costs: the most important of these fixed costs are rent, maintenance, insurance, taxes and management expenses. For the purpose of establishing guidelines, insurance and maintenance costs can again be based upon a percentage of the plant's value: 2% for the former and 5% for the latter. Rental value used is most likely to be the annual cost of a lease on the land but in some cases land is provided at a cheap rate for a new development. The tax position is so variable in different countries that it is difficult to comment. New enterprises are often given a tax holiday of up to five years. Conventionally, management costs are considered to be annual fixed costs although this often gives rise

to questions of definition and inactive plants would not necessarily incur management costs. Normally, even the smallest plant should budget costs for management of about US$ 20 000/annum. For larger plants the allowance should be nearer US$ 50 000. Finally, the enterprise is likely to need working capital of the order of three month's production cost on which interest will also be paid.

(d) Cost of raw material and utilities: raw material cost is crucial to any procesing operation because it is usually the primary cost element per unit of capacity and is the one subject to greatest fluctuations. There is little point in attempting to discuss actual costs since these are so variable. The cost of utilities is similarly very variable and there is little point in attempting to comment on the cost of electricity, or of fuel oil since these vary so much from place to place.

It is, however, worth noting that water is an integral part of fishery process, being needed for boilers, cleaning, cooling and staff facilities. A clean ample water supply is of vital importance and some plants may have to face the cost of installing their own supply from a bore hole.

(e) Labour: this is obviously another important operational cost. There must be both administrative and clerical staff, and production workers. In large plants, production and marketing will be separate functions while in the smaller plants the same man may look after production and sales and the plant owner may well do most of his own book-keeping with minimal clerical assistance. The smaller plants again seldom have quality control laboratories which enable them to check the quality both of the incoming raw material and of the final products. This is one of the reasons why it is difficult for small plants to establish themselves and exporters of fishery products.

The quantity of labour needed for the production line depends very greatly upon the degree to which the plant is mechanized. For social reasons, it may often te desirable to provide as much employment as possible. Unfortunately, the work provided is often more suitable to the capabilities of young inexperienced staff than to the heads of families, so that it is sometimes a fallacy to assume that a fish processing plant will have much useful impact upon an unfavourable employment situation. Most machinery can be relatively easily cleaned, people carry germs and it is not always easy to supervise personal habits of staff. Importing countries which have themselves high standards of hygiene will not tolerate the import of dirty food.

Machines are often not only quicker but also more reliable than people. Looking at some simple examples and taking gutting as the first operation, a skilled man can cut about 200-240 cod, each weighing about 3 kg/man-hour. The same man would gut 300 small codling an hour but only 150 large cod. A machine can gut 25-40 fish a minute; three men can mind two machines so that they can do the work of 10-12 men.

Table 1

Building costs per ton of raw material

Capacity ton of raw material per day	Total building cost USx10^3$	Annual equivalent USx10^3$ (20-year life at 12% interest)	Cost per ton of capacity US$
1-5	30-60	4-8	18-7
6-20	40-90	5-12	4-3
21-50	65-190	9-25	2
51-100	100-240	13-32	1

Table 2

Plant and equipment costs per ton of raw material

Capacity ton of raw material per day	Total plant cost US$x10^3	Annual equivalent US$x10^3 (10-year life at 12% interest)	Annual through put in 25 days ton	Cost per ton of raw material US$
1-5	60-170	11-30	225- 1 125	49-27
6-20	160-140	28-71	1 350- 4 500	21-16
21-50	230-500	41-103	4 725-11 250	9
51-100	370-780	65-138	11 475-22 500	6

Table 3

Annual fixed costs of fish processing plants

Ton of raw material/day	Total annual fixed costs US$x10^3	Processing capacity ton of raw material	Cost per ton US$
1-5	33-40	222- 1 125	147-36
6-20	40-70	1 350- 4 500	30-16
21-50	64-105	4 725-11 250	14- 9
51-100	99-140	11 475-22 500	9- 6

Table 4

Indicative capital costs of fish processing plants
(annual equivalent basis)

Capacity ton of raw material/day	Building costs US$x10^3	Plant costs US$x10^3	Miscellaneous[a/] US$x10^3	Total costs US$x10^3	Cost per ton of raw material US$	Cost per ton of raw material at two-thirds capacity US$
1-5	4-8	11-30	6-14	21-52	93-45	140-67
6-20	5-12	28-71	12-30	45-113	33-25	50-38
21-50	9-25	41-103	18-47	68-175	14-16	21-14
51-100	13-32	65-138	29-62	107-232	9-10	14-15

a/ Calculated at 10% site costs; 10% contingency allowance and 20% freight/insurance but no allowance for taxes or duties

Note: (see Clucas, 1981)

APPENDIX 5

Factors to be Taken into Consideration when Deciding which Product to Produce in any Given Situation

So far, this paper has only dealt with production cost comparisons between various products that can be produced from fish raw material that is not at present used for human consumption. There are, however, other factors to be taken into consideration in deciding which products to produce that may be more important than mere production cost. Some of these factors are listed below.

(a) Market Requirements

Low production costs do not matter very much if the properties of the product produced do not meet the demands of the market. As an example of this one can mention that marine beef would cost almost four times as much as FPC, type B, to produce. However, marine beef can be used as a meat extender whereas FPC, type B cannot. Consequently, marine beef might well find markets where FPC, type B would (automatically) be excluded, regardless of production costs. Conversely, the product properties of marine beef might be ideal in meeting the requirements of the rural population in a developing country, but the price that would have to be charged for the product as a result of the high production costs might put it completely out of reach of the purchasing power of the target population whereas FPC, type B, although an inferior product, might be acceptable and also within the reach of what the target group in question can afford to pay for fish protein foods. One can thus conclude that investigations into market requirements and product acceptability are just as important as production cost analyses and technical feasibility studies when a decision is taken on what product to produce.

(b) Size of Market

It should be noted that the most sophisticated products analysed in this paper envisage a plant with a capacity of 1 500-2 500 t of finish product per year. As far as is known only FPC, type B is currently consumed in quantities like that on an annual basis, and even for this product, the global annual consumption is approximately 1 500-2 000 t, the bulk of which goes into food aid programmes. Considering the cost comparison between the products, it should be borne in mind that a steep reduction of the annual output could change the economies of the production radically.

(c) Availability of Raw Material on a Regular Basis

The cost comparison example in this paper is based on full capacity utilization. It should be noted that if capacity utilization has to be curtailed because of insufficient or irregular supplies of raw material, the production economies of capital intensive products will suffer more than the economies of labour intensive produce.

(d) Technological Complexity of the Production Process

Some products are more complex to produce than others, and the more complex the process, the higher are the chances that something can go wrong or break down. Moreover, if the environment into which a complex production process is introduced is not very sophisticated, chances are that things will break down reasonably quickly and will not be all that easy to repair. Care should, therefore, be taken not to introduce a production process that is more complex than the environment can handle.

APPENDIX 6

Survey Research Items for Fisheries Product[1/]

FISHERIES AND MARINE PRODUCTS INDUSTRY SURVEY

Fish landing, infrastructure, climate, labour availability, customs and traditions, regulations for fishing and the industry fishery industry development plants.

COST SURVEY

Raw fish material, utilities, additives, labour and administrative, insurance, financial, packing material.

MARKET SURVEY

Nation's main protein sources, price of favourite foods and dishes.

STUDY ON THE POSSIBILITY OF OVERSEAS ECONOMIC ASSISTANCE

Study on the workability of possible economic cooperative linkage.

FISHERIES AND MARINE PRODUCTS INDUSTRY SURVEY

Fish Landing

Species \ Catch		Fish landing in tons per			Remarks
		day	month	year	
Trash fish					i.e., last few years trends
Commercial fish					

1/ See Mitsubishi Corporation, 1981

Infrastructure Facilities

Items \ Data	Data collected		Remarks
Fish Boats	Numbers: Type and size:		
Piers			
Fresh water supply	Capacity: Quality:	tons a day	
Ice water supply	Capacity:	tons a day	
Cold storage facility	Capacity temperature:	m^2 ^oC - ^oC	
Fish processing plant			

Climate

Item \ Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Temperature ^oC												
Humidity %												
Rain fall mm												
Wind max. m/sec.												

Labour Availability and Cost

Number / Salary — Class	Number available	Monthly salary	Remarks
Workers men			
Workers women			
Technicians operators			

Customs and Traditions

Customs	Descriptions

Regulations for Fishing and the Industry

Regulations	Descriptions

Fishery Industry Development Plans

Plans / Agencies	Period	Outline of plans

COST SURVEY

Price of Raw Fish Material

Conversion rate: US$ =

Species / Unit price		/t	Remarks
Trash fish			i.e., fresh or frozen
Commercial fish			

Utilities, Additives, etc.

Items \ Unit price	Unit price	Remarks
Fuel (Bunker-O oil for boiler)		
Electricity		
Fresh water		
Salt		
Alcohol		
Sodium bicarbonate		
Vinyl bags 20 kg		

Administrative and Financial Expenses

Items \ Expenses	Expenses
General Administrative Expenses	/year
Financial Expenses	Interest rate %/year
Insurance against damage	Premium /year

MARKET SURVEY

Items	Names of protein	Unit price
Main animal protein sources		
Main vegetable protein sources		
Nation's favourite food, dishes		

APPENDIX 7

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PACKAGING OF DRIED FISH IN MALAYSIA IN PERSPECTIVE

by

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ABSTRACT

Processing methods and packaging material for Malaysian dried fish are described. The most frequently used packaging materials are hessian sacks, cardboard cartons, wooden boxes and bamboo or rattan baskets. Much of this material is second hand. The major area for improvement is seen to be in packaging at the retail level.

INTRODUCTION

Although dried fish has been processed in Malaysia for ages, improvement in the keeping quality of the commodity has not undergone any significant change since an intensive survey by Hanousek (1970) at MARDI. Estimates of up to 25% of all the dried fish is lost due to spoilage during storage. The only possible way to decrease or minimize this loss is by proper control of the processing parameters: handling, distribution and storage. Packaging is, therefore, directly related to the efficiency of storing dried fish. Any package adopted can only at most maintain existing quality, it will never be able to increase the quality of the packed item. Aesthetic appeal and quality are two distinct parameters. To assess the need for proper packaging of dried fish in Malaysia, it is essential to trace the way it is handled right from the raw material and ultimately to the mass consumer.

It has been found that dried fish of lesser value, such as yellow banded scad (Carangidae), *gorami*, jewfish (Aciaenidae) are not iced during auctioning on shore. Fish that are to be processed and those of higher value are iced. The fish are bought in large quantity, gutted and cleaned, lightly salted and dried. All this is done on the floor of the processing area. After drying, they are packed in any type of container available - such as hessian or 'gunny' sack, cardboard cartons, wooden boxes, bamboo and rattan baskets. The fish is kept here until there is a purchaser. In some cases, the preparation of this fish is by special arrangement. Dried fish is mainly processed in the northwest and northeast and are sent to the central area of the country for distribution. Wholesalers from this area will request a desired quantity to be sent. No specific bulk package of commodity is traded. The quantity ordered is sent in corrugated cartons, or HDPE woven sacks according to personal observations in the markets. At the final retailers 15 kg, 20 kg, 10 kg of fish is received from local distributors, packed in a similar fashion in any type of boxes, HDPE bags or paper sacks. At the retail shop the fish is displayed in boxes, rolled down brown paper bags, LDPE baskets, etc. Fish is also displayed by hanging pieces on hooks. Dried fish is transported together with other general merchandise.

BULK PACKAGES

For transportation of large quantities or a number of smaller subunits as retail packs primary packs in direct contact with item and usually the pack make available to ultimate consumer.

Corrugated Box

- light (10% of the weight of a wooden container) 30% of solid cardboard box
- cost of construction is less
- design varies - overlapping flaps/non-overlapping flaps

Cardboard Cartons

- they are of varied sizes (dimension), e.g., (L x W x H) ($47\frac{1}{2}$ x 32 x 44)
- usually of light brown colour with the liners of 0.016-0.034 in thick 100% waste paper of low grades (Sacharow, 1976)
- these are often cartons that have been used to pack toilet paper, detergent, condensed milk, etc.
- fluting of B flute/A flute or A flute/A flute are frequent and are 5 plys and 3 plys
- boxes usually have torn flaps or damaged corners ... as they have been used before

Rattan/Bamboo Baskets

- dimension varies

Wooden Boxes

- usually fresh fish boxes
- most frequent dimensions are:

  i) East coast - capacity max. of 60 kg (wet fish)
  ii) West coast - capacity max. 110-120 kg

- no top closure; box closed by means of newspaper of hessian
- price US$ 1.50/box

Secondary Intermediate Packages (packages that are used for transit)

Hessian sacks

- similar to sacks used for paddy
- single wrap
- no liners or laminations
- stitched sides

HDPE wooven sacks

- no liners

Both the packs are closed by twisting the top part of the sack and tying the twist with a plastic strip.

Paper bags

- No. of plys varies from 1 to 5
- paper grade varies according to availability

Retail Pack

- display in small brown paper bags of various sizes and grades
- HDPE baskets
- boxes
- plastic bags - LDPE/HDPE

Final packing is in newspaper or LDPE bags

Drawbacks/improvement

Cardboard cartons and corrugated boxes partially serve the purpose since these bulk packages reach their destination within 9-10 h. They usually reach the retail shop in the early evening. Limited by lack of protection from moisture.

Improvement can be made by a loose liner which is water-proof in case of rain. LDPE/HDPE bitumen sandwich kraft paper, waxed paper of suitable grammage can be used.

These cartons are cheap because they are second hand but have poor stacking ability as the boxes have already lost mechanical strength because of dented/damaged corners.

Rattan/Bamboo

Baskets give no protection from infestation by insects-roaches, rats, flies and are not water-proof.

They are not stackable because of their shape and are therefore space consuming and well as being heavy.

Therefore, this pack is probably the most unsuitable package.

Improvements

The major improvement that needs to be made in the packaging of dried fish is at the retail level. It is here that they are displayed unprotected by any kind of package. It is also at these retail stores that the dried fish spends its longest distribution period, 3-4 weeks (after that they are often unsaleable). Therefore, it is the most crucial point of package development/innovation.

Factors to be considered in the selection of the package material are:

- product characteristics
- environmental/marketing
- resistance offered by packaging material
- surface area of the pack
- seal efficiency

Product Characteristics

- attractive to insects and pests
- sensitive to oxidation
- not fragile
- light density
- hygroscopic
- size variation
- composition
    i) moisture content 22.5-49.7%
    ii) salt 7.6-37.5%
    iii) fat

Composition is critical for effective packaging, the moisture content of the dried fish must be 15-20%, anything greater than this limit, will not be packed effectively (Heiss and Eichner, 1970).

The salt content is proportional to the moisture content. The more salt present, the more hygroscopic is the product, and therefore, it requires a lower vapor/gas permeable packing material.

On oxidation fat will contribute to the rancidity of the product. Therefore, the package chosen should have a fairly good light barrier and low O_2 permeability. Flexible packaging materials can be manufactured with U.V stabilizers added.

Dried fish in Malaysia is often displayed in any available space in the store. They are displayed in the areas where there is plenty of light or directly on the side walk of the store, therefore, there is a need for packaging material that is meant for outdoor

formulation and is also static free to prevent excessive dust accumulating on the package. Again, as dried fish is bought after visual inspection, the package must be translucent/ transparent enough to enable the customer to inspect the product. Total cost of the package should not be more than 10% of the total cost of item with some compromise between cost and intended turnover period, i.e., more expensive pack can be used for more highly priced items or items intended for longer display.

The product does not require a material with high tensile strength but, puncture resistance may be needed for dried fish with sharp protruding fins, tails. Fair tear resistance is required for fish with scales and also as a general safeguard.

The surface areas should have good resistance against abrasion, to keep the pack free of excessive scratches and to reduce the abrasion of the printing.

The package design must be correctly sized to contain the dried fish so as not to produce excessive void spaces and too much shifting of small pieces of dried fish.

The material chosen should be able to be sealed at a fairly low temperature by a simple manual sealer. This is important because the dried fish industry is not a big scale industry. Adequate sealing of seams is important so as to prevent any insect from getting into the package and also to ensure that package design is effective.

A list of available materials in the Malaysian market is given in the Appendix. To find suitable packaging material, compatibility and shelf-life studies must actually be carried out. This can be done under normal conditions or by accelerated studies.

Studies must determine:

- initial moisture content of product
- critical moisture content
- equilibrium moisture content
- odour/taste transfer

Design of package must take into consideration:

- how they are displayed - any possible new method of display
- how they are handled - roughly - throwing
- is the design pack a space saver to cut down on distribution cost?

From the above discussions, it can be summarized that in order to pack dried fish in Malaysia effectively, the following considerations must be observed:

- the fish must be dried to 15-20% moisture content
- package materials chosen must be compatible as well as of low permeability to oxygen and water vapour
- package materials must be sufficiently strong (mechanically) to meet the demands of handling and storage

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APPENDIX I

Packaging Materials Available on the Malaysian Market

(a) Flexible packaging material[1/]

1. Low polyethylene LDPE
2. High density PE (HDPE)
3. Polypropylene (PP)
4. Metalized polyester/LDPE
5. Terphane 15 x SI (PVDC/Transparent ethylene terephthalate/polyester/PVDC)
6. Claryl 15 x SI (PVDC/metalized polyester/PVDC)
7. 'C' film (PVDC/OPP/PVDC)
8. Pryphane SCBT (OPP/laminated)
9. 'M' film (OPP/PE coextruded)
10. Nylon 6-polyamide
11. PVDC/paper
12. Paper/PE
13. Paper/Al/PE
14. OPP/PE
15. Polyester/PE
16. PVDC (centerfolded)
17. Saran
18. Cellophane, e.g., $3\frac{1}{2}$ in x 18 in x 4 in - 4 plys
19. Open mouth paper bags, e.g., 50 in x 21 in x 4 in - 5 plys

(b) Rigid containers

20. Corrugated boxes $15^3/8$ in x $13\frac{1}{2}$ in x $8\frac{1}{2}$ in
21. Duplex board drums 22 in x 14 in

1/ Sell by weight or by length (100, 1 000 m)

PP is more costly than LDPE/HDPE
Any polyester/based will be costly
Al/metalized will be costly

Mohd. Ali, Y., Personal communication, MARDI, Serdang, Selangor

EXPORT PROSPECTS OF DRIED MARINE PRODUCTS FROM INDIA

by

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ABSTRACT

A diversification programme to enter new markets like Japan, Hong Kong, Singapore and Malaysia with both traditional and non-traditional dried marine products is described. Non-traditional items such as dried squid were processed by sundrying as a traditional method, in comparison to application of cool air mechanical driers. Also improvement of traditional products such as dried *Acetus* increased product acceptability/marketability. Attempts to produce boiled, dried anchovies, as required by the importing country is briefly described in addition to highlighting an exercise in producing dried sardines. Also accounted on the success of export of accelerated freeze dried shrimps to Japan is noted.

INTRODUCTION

Present Status

India is now recognized as one of the leading exporters of marine products in the world and exported 75 375 t valued at approximately US$ 280 million in 1981. Exports of dried fish are recorded in export growth. Table 1 gives the composition of total marine products exports from India and the percentage share of dried fish. Though Sri Lanka and Mauritius are India's traditional markets, in recent years a few Southeast asian countries, including Japan, have shown keen interest in the import of dried fish from India. Table 2 gives the current export record of dried fish from India to major markets. Major items of dried fish exports are *Cybium, Thynnus, Caranx,* Bombay duck, mackerel, etc.

PROCESSING AND PACKING - TRADITIONAL SYSTEM

The majority of exports are salted and sun-dried although the Integrated Fisheries Project in Cochin has experimented with a mechanical drier for internal markets. Packaging is traditionally with palmyra leaf mats.

DIVERSIFICATION PROGRAMME

In 1980, a group in MPEDA started developing diversified products and markets. Under this programme a few products, of both traditional and non-traditional nature, were developed and tried in new markets to assess their product acceptability.

Dried Squids

Export of squids and cuttlefish ranks as the fourth major item of export among marine products export from India. Market potential for dried squids was identified and processing and packing methods described (Santhana Krishnan, 1982 and 1982a). Considering the export potential in Japan and the unit value realization, attempts were made to produce this product.

From the information gathered, it is known that dried squids are sun-dried in Japan and Canada. However, Thailand, which is the major supplier to Japan, produces with mechanical driers having cool air drying systems, unlike the hot air mechanical driers used for

processing dry fish. Canada is emerging as one of the leading producers of sun-dried squid. It is presumed that the natural atmospheric conditions in the temperate climate with sunlight and sufficient velocity of cool air may facilitate the production of similar quality products as those from cool air drying. Having this basic knowledge, attempts were made in the present exercise by:

1. sun drying - but with complete fly proofing:
2. drying in air conditioned room by cool air circulation;
3. in a closed room with tin sheet/asbestos roofing, fitted with exhaust fans at one end and open windows at the other end for free flow of air.

Products dried under these conditions were compared. Exclusively sun drying resulted in brittleness, especially in bright sunlight. Materials dried in the air-conditioning system, though appearance was acceptable, took more than two days and the colour was not so appealing. Therefore, in the next trial, products were dried to begin with for first six to eight hours in the open sunlight and thereafter dried in the tin-sheeted shed with air movement. Products developed were assessed for product acceptability during the Foodex Fair, held in Tokyo in March 1982. Product acceptance was based on taste, texture, appearance, colour, flavour and freshness of the material. Of those who responded 80% were positive. As regard to taste 28% were of the opinion that the taste was similar to Japanese dried squid, and 16% stated that it was better in taste.

With regard to appearance, 60% felt it was better than other similar products; 20% felt it was similar and the balance (20%) not as good.

Flavour :	52% not different
	32% better
	16% worse
Freshness:	56% not different
	36% better
	8% worse

An interesting finding in this exercise was that ordinary house wives did not find much difference between the products developed and similar products in the market. In view of the positive response, it is felt that the introduction of this non-traditional dried product into a market which is new for such dried item from India is a success. A few processors are now involved in commercial production. Packaging is in polythene sheets and in turn in master cartons like frozen products rather than traditional ones.

Dried *Acetus*

This is a potential item identified for a non-traditional export market in Japan. The landings are recorded as 50 000 t and estimated potential is almost three times more than present landings. At present it is sun dried and packed in gunny bags for sending to the interior of the country.

The following draw backs were identified in the traditional system of drying and packing.

1. Since drying is done mostly on sandy beaches, the products are admixed with large amounts of sand and other extraneous matter is picked up during drying.

2. The finished product does not confirm to any uniform quality standard.

3. When packed and kept in gunny bags, finished product changes its colour to yellow and then to a dark colour from its original light colour within a month.

At present traditional sun-drying methods are used but the following modified methodology was adopted for producing wholesome products (Santhana Krishnan, in press).

1. Materials were well washed and drained before drying.

2. Washed material was spread uniformily in a thin layer over polythene sheet (black or white) spread on a raised platform. This avoids mixing of sand and contamination with microbes,etc.,as there is no direct contact with the ground, where workers use to walk while working.

3. When partially dried, the material was turned over to facilitate uniform drying.

The bulk samples thus prepared were packed in polythene packets and stored in a chill room. By this means of packing and storing, no change in colour was experienced for more than 70 days, in comparison with product packed in gunny bags. The samples were readily accepted by the buyers, when sent for assessment of product acceptability. This information is now under dissemination to dry fish exporters, especially in the Maharastra and Gujarat regions and it is expected that there will be a sizable movement of this item into export market, in the near future.

Boiled and Dried Anchovies

Dried anchovies (spratts) is a regular item of production in India, for both internal and traditional export markets, namely Sri Lanka and Mauritius. A recent market survey by an Indian delegation to Southeast Asian countries revealed that there exists potential markets in Singapore, Hong Kong, Malaysia, etc. The traditional system of drying this item is by sunlight in open beaches, but with the view of getting better product, samples were prepared by using mechanical driers and sent to prospective buyers. The response was negative but it was discovered that in Southeast Asia the fresh anchovy is boiled before drying. Therefore, a Project was initiated for a joint venture programme where the buyer passes on technical know-how. This integrated approach should enable better utilization of pelagic resources and enable new markets to be opened up.

Dried Sardines

This is another major pelagic resource in India, with an estimated potential of 4,00,000 t now amounting to 1,70,000 t a year. A major share of these landings utilized for fresh consumption, followed by canning, and fish meal production in peak seasons. Introduction of purse seining in recent years has contributed to landing potential, but there is no drying except for sporadic instances in the Mangalore area. Utilization in dried form was felt to be appropriate to optimum utilization of this resource, as Japan is apparently interested in importing considerable quantities of dried sardines. Therefore, dried sardines with salt and without salt, gutted with head-on were prepared and sent to determine the buyer's response.

The buyers considered that the samples had ammoniacal odours but samples sent via FAO to assess consumer acceptance in Somalia were found to be acceptable. Samples were prepared by sun drying, but care was taken as explained above in the preparation of anchovies. Attempts are in progress in introducing the tent driers as reported by Doe *et al.* (1977).

Accelerated Freeze Dried Shrimps

Export of freeze dried shrimps has now begun from India to Japan. Processing is exclusively by sophisticated freeze-drying machinery. The unit value realization is up to US$ 25 kg.

Table 1

Itemwise export and their percentage share in total export of marine products from India[a/]

Q = Quantity in tons
V = Value in I.Rs.'000

Item		1980	share %	1981	share %
frozen shrimp	Q.	47 762	64.07	54 538	72.36
	V.	1 833 661	83.78	2 485 210	86.68
frozen froglegs	Q.	3 095	4.15	4 368	5.80
	V.	73 200	3.34	119 570	4.17
frozen lobster tails	Q.	501	0.67	636	0.84
	V.	27 889	1.27	47 003	1.64
frozen cuttlefish	Q.	1 603	0.91	1 488	1.97
	V.	30 326	0.57	32 525	1.13
frozen squids	Q.	2 179	2.92	1 314	1.74
	V.	25 084	1.15	15 690	0.55
fresh and frozen fish	Q.	11 195	15.02	8 565	11.36
	V.	111 939	5.11	94 526	3.30
canned shrimp	Q.	365	0.49	100	0.13
	V.	15 794	0.72	4 900	0.17
dried shrimp	Q.	124	0.17	56	0.07
	V.	1 349	0.06	809	0.03
dried fish	Q.	4 340	5.82	1 523	2.03
	V.	20 802	0.95	14 408	0.50
sharkfins and fish maws	Q.	332	0.44	406	1.54
	V.	32 526	1.49	38 811	1.35
other items	Q.	3 046	5.34	2 381	3.16
	V.	16 186	1.56	13 676	0.48
total	Q.	74 542	100.00	75 375	100.00
	V.	2 188 756	100.00	2 867 128	100.00

a/ Source: Marine Products Export Review - 1981.

Table 2

Export of dried fish to major markets

Q = Quantity in tons
V = Value in I.Rs. lakhs
A = Average unit value I.Rs./kg

Markets		1981	1980	1979	1978
Sri Lanka	Q.	846	3 932	3 362	5 928
	V.	46.78	178.70	149.78	282.16
	A.	5.53	4.54	4.46	4.76
Mauritius	Q.	320	-	197	254
	V.	59.66	-	15.19	26.11
	A.	18.64	-	7.71	10.28
U.K.	Q.	145	17	10	8
	V.	11.88	5.48	2.02	1.46
	A.	8.19	32.24	20.20	18.25
Singapore	Q.	84	121	19	4
	V.	8.25	6.66	11.98	0.78
	A.	9.82	5.50	63.05	19.50
UAE	Q.	72	2	1	Neg.
	V.	5.74	0.11	0.11	0.03
	A.	7.97	5.50	11.00	-
Hong Kong	Q.	39	8	1	-
	V.	9.29	7.98	1.23	-
	A.	23.82	99.75	123.00	-
Others	Q.	17	260	138	117
	V.	2.48	9.09	9.03	10.81
	A.	14.59	3.50	6.54	9.24
Total	Q.	1 523	4 340	3 728	6 311
	V.	144.08	208.02	189.34	321.35
	A.	9.46	4.79	5.08	5.09

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